RESEARCHES IN ZOOLOGY.

RESEARCHES IN ZOOLOGY,

ILLUSTRATIVE OF

THE STRUCTURE, HABITS, AND ECONOMY

OF

ANIMALS.

BY

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PREFACE.

As frequent inquiries have been recently made for my 'Researches in Zoology,' which were published collectively in the year 1834, and have long been out of print, I have been induced to offer to the public a second edition of the work, which will be found to comprise such additions and emendations as subsequent investigations have enabled me to effect.

The descriptions of British Spiders given in the first edition of the 'Researches' are here omitted, as they are all included in a 'History of the Spiders of Great Britain and Ireland' issued by the Ray Society, to which work I refer those zoologists who take an interest in that department of our native Fauna.

I may remark that the materials of which the present volume is composed have been collected, for

the most part, during intervals of relaxation from more important avocations; and it is hoped that they may be found to contain information on various subjects interesting to the general reader and to the natural philosopher.

Hendre House,
August 22nd, 1872.

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ERRATUM.

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RESEARCHES IN ZOOLOGY.

ON

THE MIGRATION OF BIRDS.

An accurate and comprehensive history of the Periodical Birds may now be considered one of the greatest desiderata in ornithology. Hitherto little has been done to elucidate the manners and economy of this interesting portion of the feathered tribes, as connected with their periodical appearance and disappearance; for although much has been written on the subject, yet few facts of any considerable importance have been ascertained; and even those few lie scattered through the writings of such various authors, and are so blended with what is erroneous or merely conjectural, that it is no easy task to distinguish and collect them: consequently our knowledge of the circumstances which regulate the motions of the

numerous species of Periodical Birds is still very imperfect; and we are almost entirely ignorant of the places of their retreat, and of the mode of their existence in those retreats. Whether, when they withdraw, they depart from those districts and countries in which they cease to appear, or whether they conceal themselves and remain in a state of torpidity, has not yet been positively determined; and opinions must continue to be divided on the subject so long as authors indulge in fanciful speculations, instead of collecting and arranging well-authenticated facts, from which alone legitimate conclusions can be deduced.

The accumulation of facts, then, appears to be the most important object to be attained at present; and my principal motive for giving publicity to the following Tables and remarks is the hope that they may be found to contribute, in some degree, to increase our scanty stock of information on this obscure branch of natural history.

It is remarkable that almost all the catalogues of Periodical Birds with which I am acquainted have been formed from observations made in the south of England. This circumstance is certainly calculated to give additional interest to the following Tables, made in so northern a county as Lancashire. In forming them I have ventured to deviate a little from the usual mode of arrangement, having separated those birds which are irregular in the times of their

appearance and disappearance, and those species also which are periodical in particular districts only, from the regular summer and winter birds, and have classed them under appropriate heads. I have, however, retained the Stonechat and Pied Wagtail among the summer birds, and the Snipe and Wild Duck among the winter birds; for though individuals of the first two species frequently remain through the winter in the southern counties, and though considerable numbers of Snipes and Wild Ducks breed with us annually, yet the periodical appearance and disappearance of a very large proportion of these birds cannot, I think, be questioned. Many of the larger species of aquatic birds included in the Tables are rarely seen in the vicinity of Manchester, except during severe frosts or after violent storms of wind; of course their appearance is uncertain, and their stay is generally short.

The remarks consist chiefly of details of such circumstances relative to the migration of birds as have fallen under my own observation, and of conclusions drawn from them and from an attentive consideration of the facts recorded by others.

Tables of the various Species of Periodical Birds observed in the neighbourhood of Manchester.

The Periodical Birds may, with propriety, be arranged under four distinct heads:—

1st. The Summer Birds, or those species which appear during the spring months and retire in autumn.

2nd. The Winter Birds, or those species which appear during the autumnal months and withdraw in spring.

3rd. Birds which are irregular in the times of their appearance and disappearance.

4th. Birds which are partially periodical, retiring in particular districts only.

The Tables contain those species of Periodical Birds which visit the neighbourhood of Manchester, classed according to the above method; the times of their arrival and departure, taken at an average of fifteen years' observations, commencing with 1814 and terminating with 1828, and the general mean temperature of those days on which they have appeared and disappeared during that period, found from the extremes indicated by a pair of Rutherford's horizontal self-registering thermometers exposed to the open air in a shady situation, being also given.

It is proper to intimate that I have employed the nomenclature of the second edition of M. Temminck's 'Manuel d'Ornithologie' throughout the volume in treating upon European birds; but that, as regards extra-European species, the names, for the most part, are accompanied by the authorities I have adopted.

TABLE I.—*Periodical Summer Birds.*

Birds.	Appear.	Temperature.	Disappear.	Temperature.
Pied Wagtail (*Motacilla alba*)*	Mar. 13	49°	Oct. 18	49°
Wheatear (*Saxicola œnanthe*)	April 6	43	Sept. 21	53
Sand-Martin (*Hirundo riparia*)	„ 9	48	„ 15	55
Wryneck (*Yunx torquilla*)	„ 11	45	„ 9	55
Yellow Wren (*Sylvia trochilus*)	„ 11	48	„ 17	56
Redstart (*Sylvia phœnicurus*)	„ 13	50	„ 14	59
Yellow Wagtail (*Motacilla flava*)	„ 13	47	„ 16	54
Lesser Field-Lark (*Anthus arboreus*)	„ 14	51	„ 13	55
Swallow (*Hirundo rustica*)	„ 15	50	Oct. 7	53
Cuckoo (*Cuculus canorus*)	„ 20	47	June 27	59
House-Martin (*Hirundo urbica*)	„ 25	47	Oct. 10	53
Whinchat (*Saxicola rubetra*)	„ 26	52	Sept. 18	55
Black-cap (*Sylvia atricapilla*)	„ 27	48	„ 7	60
Pied Flycatcher (*Muscicapa luctuosa*)	„ 27	44	„ 4	55
White-throat (*Sylvia cinerea*)	„ 28	52	„ 15	55
Wood-Wren (*Sylvia sibilatrix*)	„ 28	50	„ 6	57
Stonechat (*Saxicola rubicola*)	„ 28	52	Oct. 24	51
Lesser White-throat (*Sylvia curruca*)	„ 30	55	Sept. 7	58
Sedge-Warbler (*Sylvia phragmitis*)	May 3	53	„ 10	61
Pettychaps (*Sylvia hortensis*)	„ 4	52	„ 10	60
Sandpiper (*Totanus hypoleucos*)	„ 4	58	„ 10	56
Grasshopper-Warbler (*Sylvia locustella*)	„ 5	52		
Swift (*Cypselus murarius*)	„ 8	50	Aug. 17	58
Spotted Flycatcher (*Muscicapa grisola*)	„ 11	51	Sept. 18	58
Land-Rail (*Gallinula crex*)	„ 13	53	Oct. 7	49
Goatsucker (*Caprimulgus europæus*)	„ 15	53	Sept. 8	57
Red-backed Shrike (*Lanius collurio*)	„ 19	54	„ 13	55
Lesser Pettychaps (*Sylvia hippolais*)	....	...	„ 21	56
Spotted Gallinule (*Gallinula porzana*)	....	...	Oct. 15	45
Quail (*Perdix coturnix*)				
Hobby (*Falco subbuteo*)				
Turtledove (*Columba turtur*)				
Dottrel (*Charadrius morinellus*)				
Common Tern (*Sterna hirundo*)				
Lesser Tern (*Sterna minuta*)				
Black Tern (*Sterna nigra*)				
Puffin (*Mormon fratercula*)				

* This Wagtail, formerly supposed to be identical with the *Motacilla alba* of Linnæus, but now known to be distinct from it, has had the specific name of *Yarrellii* conferred upon it.

TABLE II.—*Periodical Winter Birds.*

Birds.	Appear.	Temperature.	Disappear.	Temperature.
Snipe (*Scolopax gallinago*)	Sept. 10	58°	April 5	45°
Jack Snipe (*Scolopax gallinula*)	Oct. 1	56	„ 3	44
Water-Rail (*Rallus aquaticus*)	„ 7	52	„ 12	44
Great Snipe (*Scolopax major*)	„ 12	58		
Redwing (*Turdus iliacus*)	„ 13	52	Mar. 29	46
Grey-lag Goose (*Anas anser*)	„ 17	52	April 2	43
Short-eared Owl (*Strix brachyotos*)	„ 20	46		
Mountain-Finch (*Fringilla montifringilla*)	„ 21	48	April 10	40
Woodcock (*Scolopax rusticola*)	„ 21	50	Mar. 29	43
Wild Duck (*Anas boschas*)	„ 21	52	„ 24	41
Smew (*Mergus albellus*)	„ 23	38		
Goosander (*Mergus merganser*)	„ 24	40		
Fieldfare (*Turdus pilaris*)	„ 27	45	Mar. 31	41
Hooded Crow (*Corvus cornix*)	„ 30	44	April 13	45
Green Sandpiper (*Totanus ochropus*)	....	...	May 7	63
Snow-Bunting (*Emberiza nivalis*)	....	...	Feb. 27	38
Greenshank (*Totanus glottis*)				
Godwit (*Limosa rufa*)				
Hooping Swan (*Anas cygnus*)				
Bernacle Goose (*Anas leucopsis*)				
Golden-eye (*Anas clangula*)				
Pochard (*Anas ferina*)				
Widgeon (*Anas penelope*)				
Teal (*Anas crecca*)				
Little Auk (*Uria alle*)				

TABLE III.—*Birds which are irregular in the times of their appearance and disappearance.*

Birds.	Appear.	Temperature.	Disappear.	Temperature.
Great Cinereous Shrike (*Lanius excubitor*)	April 21	49°		°
Hoopoe (*Upupa epops*)	May 16	58	Sept. 26	53
Crossbill (*Loxia curvirostra*)	Aug. 5	59	Nov. 19	43
Siskin (*Fringilla spinus*)	Nov. 24	39		
Hawfinch (*Fringilla coccothraustes*)	Dec.			
Bohemian Wax-wing (*Bombycivora garrula*)	„			
Golden Oriole (*Oriolus galbula*)				
Rose-coloured Pastor (*Pastor roseus*)				
Olivaceous Gallinule (*Gallinulà pusilla*)				

TABLE IV.—*Birds which are partially Periodical.*

Birds.	Appear.	Tempe-rature.	Dis-appear.	Tempe-rature.
Throstle (*Turdus musicus*)	Jan. 23	39°	Nov. 14	45°
Starling (*Sturnus vulgaris*)	Feb. 12	41	Oct. 16	49
Common Bunting (*Emberiza miliaria*)	Mar. 6	38	„ 16	56
Reed-Bunting (*Emberiza schœniclus*)	„ 10	46	„ 4	55
Greenfinch (*Fringilla chloris*)	„ 14	48	„ 18	54
Lapwing (*Vanellus cristatus*)	„ 27	49	Sept. 29	57
Lesser Redpole (*Fringilla linaria*)	April 10	47	Oct. 21	47
Mountain-Linnet (*Fringilla montium*)	„ 22	50	Sept. 17	56
Grey Wagtail (*Motacilla boarula*)	Sept. 7	57	April 11	44
Merlin (*Falco æsalon*)	Oct. 13	49	„	
Ring-Ouzel (*Turdus torquatus*)	„ 19	49		

REMARKS.

The gradual increase of temperature in spring, and its decrease in autumn, are circumstances which seem to be so closely connected with the appearance and disappearance of the Periodical Birds that they have long been regarded as the primary causes of those phenomena. In reflecting on this very generally received opinion, it occurred to me that I had never met with any attempt to ascertain how nearly the temperature of the time of the appearance of the Periodical Birds coincides with the temperature at the time of their departure; and, as this is a consideration of much importance, I have endeavoured, at least in some measure, to supply the deficiency.

According to the Tables, it seems that, with a few exceptions, the temperature is considerably higher when the Periodical Summer Birds withdraw than it

is when they appear; and with regard to the Cuckoo and Swift, this is uniformly the case in a remarkable degree: but, as the motions of the Periodical Birds may be supposed to be influenced by the weekly or monthly rather than by the daily mean temperature, I shall compare the mean temperature of April, the month in which most of the Summer Birds are first seen, with that of September, the month in which they chiefly retire, prefixing the sign + to the difference of the means when the temperature at the time of their departure is in excess, and the sign — when it is in defect.

A comparative view of the mean temperature of April and September from 1814 *to* 1828 *inclusive.*

	1814.	1815.	1816.	1817.	1818.
April	49°·4	45°·2	45°·5	46°·8	45°·1
September	55·5	54·4	56·0	58·9	58·3
Difference of means	+6·1	+9·2	+10·5	+12·1	+13·2
	1819.	1820.	1821.	1822.	1823.
April	50°·5	50°·7	48°·5	46°·5	44°·0
September	57·1	56·1	58·4	54·4	53·8
Difference of means	+6·6	+5·4	+9·9	+7·9	+9·8
	1824.	1825.	1826.	1827.	1828.
April	45°·6	47°·8	47°·2	47°·4	46°·4
September	57·0	59·6	56·7	56·2	57·8
Difference of means	+11·4	+11·8	+9·5	+8·8	+11·4

General mean for April 47°·1, for September 56°·6. Difference of means +9°·5.

Still the temperature, at the time of the disappearance of the birds under consideration, is found greatly in excess. We will now examine how nearly the mean of October corresponds with that of April.

A comparative view of the mean temperature of April and October from 1814 *to* 1828 *inclusive.*

	1814.	1815.	1816.	1817.	1818.
April	49·4	45·2	45·5	46·8	45·1
October	46·3	49·1	50·6	46·3	56·5
Difference of means	−3·1	+3·9	+5·1	− ·5	+11·4
	1819.	1820.	1821.	1822.	1823.
April	50·5	50·7	48·5	46·5	44·0
October	50·1	47·7	50·5	51·0	47·2
Difference of means	− ·4	−3·0	+2·0	+4·5	+3·2
	1824.	1825.	1826.	1827.	1828.
April	45·6	47·8	47·2	47·4	46·4
October	48·4	51·5	52·4	52·8	50·2
Difference of means	+2·8	+3·7	+5·2	+5·4	+3·8

General mean for April 47°·1, for October 50°. Difference of means +2°·9.

A near approximation is observable in the temperature of these months, allowing for the unusual warmth of the latter in 1818; yet the Stonechat, Pied Wagtail, Swallow, House-Martin, and Land-Rail are almost the only summer birds seen in October, and they generally retire before the termination of the third week; though Bats, Dormice, Hedgehogs, and

various coleopterous and dipterous insects, &c. are visible till the close of November, and even through the winter when the weather is open. In the year 1820 Long-eared Bats were observed nearly to the middle of November; and in 1821 they were first noticed on the 23rd of April, the mean temperature for the day being 50°·5, and were seen through November to the 8th of December, when the mean temperature was 46°, the mean for November being 47°, which is within 1°·5 of that of April for the same year.

Now, if the Periodical Summer Birds when they withdraw do not migrate into more genial climates, they must retire to suitable retreats in which they pass the winter months in a state of torpidity. But where are such retreats to be found? The notion of the submersion of these birds in lakes, ponds, and rivers is too absurd to merit a moment's consideration, as they are not only specifically lighter than water, but quite unfitted for existence in it by their organization.

Mr. Gough, in his remarks on migration, published in the 'Memoirs of the Literary and Philosophical Society of Manchester,' vol. ii. new series, from a consideration of the laws which regulate the temperature of the earth at all moderate depths beneath its surface *, clearly establishes the fact that deep caverns

* Those who wish for information on this subject may consult Saussure's 'Voyages dans les Alpes,' tome iii. chap. xviii.

cannot be the winter-retreats of the Periodical Summer Birds, as their temperature is not far from the maximum when these birds retire, and is near the minimum about the time that they begin to appear. He then proceeds to observe (pp. 461, 462) that "very few arguments will be now required to demonstrate the impossibility of the analogy which is supposed to connect the periodical birds of summer and the sleeping animals of winter. It is sufficient barely to remark, that the former are never found slumbering with the latter near the surface of the earth, and deep caverns are proved to be unfit for the reception of any creature in the torpid season. Consequently the birds in question desert the temperate zones at the approach of winter, to seek a better climate in lower latitudes." These conclusions, however, will appear to have been formed rather hastily, when we consider what numbers of Bats become torpid every winter in this country, and how rarely they are discovered in their dormitories. Might they not have been derived more satisfactorily from the circumstance of the Summer Birds being seldom or never found abroad with the sleeping animals during the mild weather which we frequently have in winter? Bats, Hedgehogs, &c. usually appear when the mean daily temperature is about 50°; but I am not aware that there is a single instance on record of any of our Periodical Warblers, properly so called, having been observed in the cold season, either in a state of active

existence or of torpidity*. A few, indeed, may occasionally be seen at the customary time in spring even when the weather is frosty, the increments of temperature by no means corresponding with the sun's increasing northern declination, but they generally seem to withdraw again. On the 9th of April, 1821, several Sand-Martins were observed at a sandpit in the township of Cheetham, but the weather becoming cold and stormy they quickly disappeared; they were, however, soon after discovered, in greatly increased numbers, at a sheltered bend of the river Irwell, in the adjoining township of Broughton. This circumstance proves that if the weather is severe and boisterous when the Summer Birds are first seen in spring, they do not retire to their winter retreats, as has been supposed, but merely seek sheltered situations where they can procure a supply of food.

Inquiries into the temperature of the supposed winter retreats of the Periodical Summer Birds may now be looked upon, it is presumed, as quite superfluous, since it is sufficiently apparent from the preceding Tables that even that of the atmosphere is much higher at the time these birds disappear than it is when they appear, the very reverse of what ought to be the case if they become torpid,

* Since writing the above I find that Montagu, in the Supplement to the 'Ornithological Dictionary,' asserts that he has occasionally discovered the Lesser Pettychaps (*Sylvia hippolais*) in the south of Devonshire in mild winters.

and of what is actually found to be so with the sleeping animals of winter; indeed, as torpidity does not appear to be induced in any British vertebrate animal by a degree of temperature superior to that which is required to revive it from its lethargic state, it is evident that the birds in question must migrate*. As there are, however, several other curious facts relating to the Periodical Birds which throw great light on the subject of migration, and powerfully tend to confirm this opinion, I shall proceed to examine them.

It is a surprising circumstance that several species of Periodical Summer Birds almost constantly return to the same places in the same numbers, and there are sufficient reasons for believing that these birds are generally the same individuals. Four or five pairs of Swallows, and about two pairs of Redstarts and of Spotted Flycatchers, visit our family residence in Crumpsall every spring; and White, in his 'Natural History of Selborne,' p. 230, says, "among the many singularities attending those amusing birds the Swifts, I am now confirmed in the opinion that we have every year the same number of pairs invariably;" and again, "the number that I constantly find are eight pairs." Now, as those birds usually make their

* I have never been able to induce torpidity in the Cuckoo, or in birds of the Swallow tribe, by any experiments which I could devise; though with animals of known torpid habits I have succeeded without difficulty.

nests in the same situations, this alone is a strong proof of their identity: great additional weight, however, is given to this proof by the peculiarity of the situations in which such birds occasionally build. For three successive years a pair of Swallows built in a pigsty belonging to a relation of mine, their ingress and egress being by a very low entrance; and in Bewick's 'History of British Birds,' vol. i. p. 253, it is stated, on the authority of Sir John Trevelyan, Bart., that "at Camerton Hall, near Bath, a pair of Swallows built their nest on the upper part of the frame of an old picture over the chimney, coming through a broken pane in the window of the room. They came three years successively, and, in all probability, would have continued to do so if the room had not been put into repair, which prevented their access to it." White, in speaking of the Selborne Swifts ('Nat. Hist. Sel.' p. 186), says, "they frequent in this village several abject cottages; yet a succession still haunts the same unlikely roofs: a good proof this," he observes, "that the same birds return to the same spots." And he remarks of the House-Martin (p. 161), that "the birds that return yearly bear no manner of proportion to the birds that retire;" and this is uniformly the case. Now Swallows and House-Martins have frequently two broods in a summer, the first consisting of about five young ones, and the second of three, upon an average; and Redstarts, Spotted Flycatchers, and Swifts have one brood, the

first two species usually rearing four or five and the last two young ones. What, then, becomes of this increase? If these young birds do not quit the country, why are they not seen in the ensuing spring? These are perplexing questions, questions which the advocates of torpidity will find it impossible to answer satisfactorily; indeed they involve difficulties which can only be removed by admitting, what is undoubtedly the case, that these birds migrate, and that, being deserted by the old ones, and losing all recollection of the places where they were brought up, they are directed in their spring flight by fortuitous circumstances, and are thus diffused over a large portion of the globe.

The highly interesting and important fact that several species of Periodical Summer Birds moult during the interval which elapses between their departure and reappearance, if generally known to ornithologists, would, it is reasonable to suppose, have been frequently and strenuously urged as one of the most conclusive arguments which could be advanced in support of migration; but notices of this nature are extremely rare, as perhaps no part of the animal economy of the feathered tribes has been so greatly neglected by natural historians as their moulting. That Swallows, Swifts, Cuckoos, Redstarts, and Spotted Flycatchers moult during their absence scarcely admits of a doubt. I have cut feathers out of the wings and tails of Swallows, so that I could

easily distinguish them when flying, and I find that such feathers are never replaced while these birds remain with us. Great numbers of young Swallows retire in autumn before the exterior feathers of their tails have acquired their full length, yet the tail-feathers of those birds which return in spring are always perfect in their growth. To these facts I shall add a few extracts from Mr. Pearson's account of his experiments, made for the purpose of preserving Swallows alive through the winter, as given in Bewick's 'British Birds,' vol. i. pp. 250, 251, which are decisive as to the moulting of this species. The first year's experiment failed; but the second attempt was completely successful, as Mr. Pearson states that "the birds throve extremely well, they sung their song through the winter, and soon after Christmas began to moult, which they got through without any difficulty, and lived three or four years, regularly moulting every year at the usual time. On the renewal of their feathers it appeared that their tails were forked exactly the same as in those birds which return here in the spring, and in every respect their appearance was the same. These birds were exhibited to the Society for Promoting Natural History on the 14th day of February, 1786, at the time they were in a deep moult, during a severe frost, when the snow was on the ground." The account is concluded by Mr. Pearson in the following words:—"Jan. 20, 1797. I have now in my house, No. 21 Great New-

port Street, Long Acre, four Swallows in moult, in as perfect health as any birds ever appeared to be in when moulting." The plumage of Swifts, from exposure to the sun and air, loses that deep soot-colour which it always has on their arrival, and becomes gradually paler till they withdraw. This circumstance has not escaped the observation of Mr. White (see his 'Nat. Hist. Sel.' p. 183). The plumage of young Cuckoos, Redstarts, and Spotted Flycatchers is very different from that of adults. Young Cuckoos have the upper parts marked with various shades of brown, mixed with black, where the old birds are dove-coloured; and the under parts are pale brown, barred with dusky brown, where the old ones are white, barred with black; in short, their appearance is in many respects so totally different from that of their progenitors, that they easily might be, and indeed often have been, mistaken for a distinct species. Young Redstarts and Spotted Flycatchers have their heads, necks, backs, scapulars, &c. spotted; the former with pale yellow and the latter with white, which is not the case with old birds; and those marks which so clearly characterize the sexes of Redstarts when their plumage is matured are altogether wanting in young birds. Now, as young Cuckoos, Redstarts, and Spotted Flycatchers do not usually appear to cast off their nest-feathers before they retire, they are readily distinguished from old birds while they stay with us; and as birds of these species

are never found to retain their first feathers on their return in spring, they must moult in their absence; and it is probable this may be the case with the Periodical Summer Birds generally*: but it would be unphilosophical to suppose that these birds, in a state of torpidity, when the animal functions are nearly suspended, can both throw off their old feathers and develope new ones; therefore they must seek those countries which supply a requisite degree of warmth, and a sufficient abundance of food, to enable them to change their feathers. It appears from the following passage, extracted from the 'Manuel d'Ornithologie' of M. Temminck, second edition, p. 426, that, with regard to the Swallow and House-Martin, this distinguished ornithologist had previously arrived at the same conclusion from a consideration of similar facts. "Je dois (he remarks) à M. Natterer de Vienne, l'observation particulièrement intéressante, que les

* In this attempt to prove that some of the Periodical Summer Birds moult during their absence, I have purposely confined my remarks to such species as are well known and easily observed. The Red-backed Shrike, Whinchat, and some others with whose habits and economy we are less familiar, might, however, be added to those already enumerated. In my opinion respecting the moulting of the Red-backed Shrike I am supported by Montagu, who affirms "that all the young, when they leave us in the month of September, very much resemble the adult female; and the whole return to us again in about six months in their full sexual plumage." See the Supplement to the 'Ornithological Dictionary.'

Hirondelles et les Martinets muent une fois l'année en février, par conséquent dans le temps de leur séjour dans les climats chauds de l'Afrique et de l'Asie; un fait d'ailleurs qui prouve incontestablement contre la prétendue torpeur ou sommeil hivernal de ces oiseaux. Les observations de M. Natterer ont été faites sur des Hirondelles élevées en cage, dont un petit nombre a vécu huit et neuf ans en domesticité." Old Cuckoos leave us late in June or early in July, when the temperature is approaching the maximum for the year; and Swifts retire about the middle of August, when the temperature, though receding from the maximum, is still very high. To what cause, then, shall we attribute the early retreat of these birds? Certainly not to a deficiency of food, as young Cuckoos are frequently found to remain upwards of two months after the old birds have left; and Swifts are occasionally seen long after the great body of their congeners has withdrawn*; and yet these individuals

* In the year 1815 I saw a Swift in the township of Crumpsall, on the 20th of October, and the same bird was seen again on the 25th, which is more than two months beyond the time at which this species usually departs, and nearly a fortnight after the last Swallows and House-Martins had left us; and in the year 1818 I saw one at Chester on the 18th, 19th, and 20th of October. I had opportunities of observing both these birds attentively for a length of time, and I remarked that they always seemed to be in the active pursuit of their prey. White, in his 'Nat. Hist. Sel.' p. 264, mentions an instance of a Swift being induced, by attachment to its young, to remain till the 27th of

procure plenty of nourishment. Is it not rather occasioned by a disposition to moult, and the want of a suitable degree of warmth to enable them to change their feathers? Our Domestic Fowls begin to moult in July, the hottest month in this latitude, and birds in a state of nature usually moult when they have done breeding; if, therefore, the temperature of July is not sufficiently high to promote the moulting of the Periodical Summer Birds, Cuckoos, as they leave the care of their progeny to strangers, and, of course, are at liberty when they have deposited their eggs, should be the first birds which withdraw. Swifts also, having only two young ones to rear, should be the next birds which retire. The Periodical Warblers, and those birds which have five or six young ones, ought to quit in the next place; and Swallows and House-Martins, which have two broods in a season, ought to be the last that depart; and this is always found to be the case; so that whether the departure of these birds be influenced by a disposition to moult or not, it seems to be regulated in a great measure by the cessation of their parental cares, and not by temperature solely.

It will be difficult to produce any direct evidence of the migration of the Periodical Summer Birds until

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August; and though deserted by its mate early in the month, it reared a second brood (the first having been destroyed) without assistance—a convincing proof that, however disagreeable it may be for Swifts to prolong their stay, they are not compelled to quit so early as they do by any difficulty in obtaining food.

their winter retreats are well ascertained*; but from what has been already advanced respecting these birds it will be seen that this fact may be satisfactorily proved indirectly, by a process of reasoning somewhat analogous to that adopted by geometricians in investigating such propositions as do not admit of a direct solution, namely, by showing that the contrary supposition involves an absurdity. It is absurd to suppose that the Summer Birds become torpid with an increased or an increasing temperature, or that they can change their feathers in such a state when the organs of secretion are known barely to perform their several offices; or that, under such circumstances, scarcely more than one fourth of those birds which withdraw in autumn should reappear in spring, though the same birds almost constantly return to the same haunts: these suppositions, I repeat, are

* Adanson asserts that European Swallows pass the winter in Senegal, but does not particularize the species (see his 'Histoire Naturelle du Sénégal,' p. 67); and it appears probable, from the observations of Mr. White's brother (the Rev. J. White), who resided at Gibraltar ('Nat. Hist. Sel.' pp. 87, 88, 139), that many of our Periodical Summer Birds may winter in Africa. The length and difficulty of such a journey are the chief objections which have been urged against this opinion; but they will cease to be looked upon as serious obstacles when we reflect that these birds may pass hence to the equator without crossing any great extent of sea, and that as they are continually advancing into better climates they are enabled to travel leisurely, there being no necessity for extraordinary haste.

manifestly absurd; therefore the Summer Birds must migrate.

Writers, in treating on the Periodical Birds, have confined their observations almost exclusively to the various species of Swallow, neglecting, in a great measure, the Short-winged Summer Birds, which seem to be the least qualified for migration, and the Periodical Winter Birds, which furnish some of the strongest arguments in support of it.

If the Periodical Winter Birds do not leave this country in spring, they must stay with us the year through; yet it is in the highest degree improbable that Woodcocks, Jack Snipes, Mountain Finches, and the numerous flocks of Redwings and Fieldfares which are seen in winter should remain here during the summer months and yet elude the observation of ornithologists. The Redwing is generally admitted to be a bird of song*; and as most of the Thrush tribe sing more or less, it is very probable that the Fieldfare is a singing bird also; yet we know nothing of their songs or summer notes, but are merely acquainted with their calls, which are heard in winter only; and I believe there are very few well authenticated instances of the nests of these birds having been found in England.

According to Linnæus, Redwings and Fieldfares

* Linnæus says that "its lofty and varied notes rival those of the Nightingale." See his 'Lachesis Lapponica,' translated by J. E. Smith, M.D. &c., vol. i. p. 6.

breed in Sweden. In his 'Fauna Succica' he says of the Fieldfare, that "maximis in arboribus nidificat," and of the Redwing that "nidificat in mediis arbusculis, sive sepibus: ova sex cæruleo-viridia maculis nigris variis;" but it is plain that they must leave that country in winter, as, with us, Redwings are among the first birds which suffer in inclement weather; and both Redwings and Fieldfares withdraw from our northern counties, and great numbers of them even quit the kingdom entirely, during long and severe frosts, especially if they are accompanied with snow*.

Scopoli, in his 'Annus Primus,' says of the Woodcock, that "nupta ad nos venit circa æquinoctium vernale. Nidificat in paludibus alpinis. Ova ponit 3–5. Migrat post æquinoctium autumnale. Fugit brumam et acre gelu;" and of the Fieldfare, that "migrat Novembri mense." Thus it appears that Woodcocks breed in the Tyrol, which they quit about the latter end of September, and that Fieldfares leave the same country in November. It is well known also that Woodcocks desert the more northern countries of Europe at the commencement of winter. Here, then, we have positive evidence of the migration of the Redwing, Fieldfare, and Woodcock, some of

* In the severe winter of 1813–14 the northern counties of England were nearly deserted by Redwings and Fieldfares, and I have been informed that at this period they were far from being plentiful in the southern counties.

their haunts, both summer and winter, being known. That Redwings and Fieldfares migrate, those persons who are acquainted with their calls may be easily convinced, as the faint scream of the former and the chattering note of the latter may be heard frequently repeated through the nights of October and November as their numerous flights pass over head; and as that is the time at which these birds visit us, and as their calls cease to be heard at night soon after that period, they must then be on their passage from some other country to this, or to countries still further south. This circumstance also establishes the fact that some species of Periodical Birds perform their migrations in the night; and it is probable that this is the case with most of them*, as I have frequently looked through the woods and plantations in Crumpsall with great care in April, the month in which most of the Summer Birds appear, without perceiving a single individual of any of the migratory tribes; yet early in the morning of the day following that on which the search was made, I have been surprised to hear the notes of the Redstart and Yellow Wren, and to find that the latter species had arrived in considerable numbers. From the undeniable fact that the males of several Migratory Summer Birds usually precede the females in spring,

* M. Temminck, in treating upon the Quail, in the second edition of his 'Manuel d'Ornithologie,' makes the following observation: "voyage le plus souvent au crépuscule ou pendant le clair de lune."

it would seem that, in these instances, the sexes do not travel in society.

Having endeavoured, in the foregoing remarks, to prove the migration of the Periodical Summer and Winter Birds, I shall here briefly observe that our irregular visitors also must migrate; as it is equally impossible that they should lie torpid during a period of several years, or that they should escape the notice of observers for so great a length of time. Thus the migration of every description of Periodical Birds, whose appearance has been difficult to account for, is established according to the sound principles of the inductive logic.

ON

THE NOTES OF BIRDS.

It is much to be regretted that the study of ornithology is too frequently confined solely to the perusal of the best authors on the subject, and to the examination and arrangement of preserved specimens, whose faded plumage and distorted forms convey very imperfect ideas of the elegance and symmetry which so eminently distinguish this beautiful and highly interesting part of the creation. To those whom business or inclination leads to reside chiefly in large towns, such are almost the only means of information which offer themselves; but who that enjoys the opportunity of observing the free denizens of the fields and woods in their native haunts would exchange their lively and unrestrained activity, their curious domestic economy, their mysterious migrations, and their wild but delightful melody, for the fixed glassy eye and the mute tongue of the inanimate forms which are crowded together in melancholy groups in the museum? Let me not, however, be misunderstood. I do not mean to insinuate that those collections of birds which enrich

the cabinets of the curious are of small utility; on the contrary, I am willing to allow that their importance is very considerable; but I would anxiously guard against an exclusive attention to the collecting and arranging of specimens to the neglect of what is much more instructive and valuable: I allude to the study of their habits, manners, and economy. In these important particulars the history of birds is still very defective, the majority of authors, foreign as well as native, having limited themselves to the simple enunciation of specific characteristics and distinctions founded principally on external structure and colour, and the occasional introduction of a few anecdotes, which, from frequent repetition, have in general lost much of the novelty they once possessed. We must except from this remark, however, the excellent works in natural history of our ingenious countryman the late Rev. Gilbert White, of Selborne, in Hampshire, which abound with new and interesting facts. This diligent observer, whose example in investigating nature cannot be too highly recommended, instead of confining himself to the mere classification of natural objects, ranged the extensive wood, the tangled brake, the solitary sheep-walk, and the treacherous morass, to contemplate the manner of life, dispositions, and peculiar characters of their feathered inhabitants in their most sequestered retreats; and his writings bear ample testimony how well his researches were repaid. The subject, however, is still far from being exhausted.

Knowledge is acquired slowly; and even the most careful and indefatigable inquirers are liable to errors and omissions. Much yet remains to be supplied, much to be corrected, before the history of British birds can be pronounced complete.

To the practical ornithologist who is desirous of promoting and extending his favourite study by the communication of his personal observations and remarks, an intimate acquaintance with the various notes of the feathered tribes is of such importance, that any difficulties he may encounter in obtaining it will be more than compensated by the numerous advantages it affords. In many instances it enables him to detect species which might otherwise elude his observation. Thus the Land-Rail (concealed in the long grass of luxuriant meadows, where it runs with great rapidity, and is sprung with difficulty), the Grasshopper-Warbler (closely embowered in thick hedges and bushy dingles, where it employs every artifice to escape notice), and the Sedge-Warbler (secluded amid the reeds and other aquatic productions of pools and marshes) are much more frequently heard than seen, the harsh call of the first, the sibilous note of the second, and the hurried song of the last; being repeated through the night, in fine weather, during the breeding-season.

It also enables him to identify species with the utmost precision; in some cases, indeed, with greater certainty than he could by the examination of speci-

mens. The Wood-Wren, Yellow Wren, and Lesser Pettychaps, for example, so much resemble each other, that even nice observers might have some difficulty in determining them by inspection; and accordingly we find that they have been a source of confusion, perplexity, and error among writers on ornithology; as their notes, however, are perfectly distinct, a little attention to them is sufficient to remove every difficulty. In the same manner the Crow may readily be distinguished from the Rook, the Raven from both, and the males of most species from the females.

The arrival of many of the Periodical Warblers is frequently first announced by their songs; and the clamorous night-calls of the Redwing and Fieldfare, in the months of October and November, serve to establish the fact that these birds migrate, and that they perform their journeys in the night.

But these are not the only advantages to be derived from an acquaintance with the notes of birds. As the feathered tribes communicate their sensations and intentions to one another through the medium of modulated sounds, the proficient in what, without any impropriety, may be termed their language, can comprehend their various wants and emotions, and can participate in all their little joys and sorrows, hopes and fears. To him the music of the groves is not a confusion of pleasing tones merely, but the melodious interchange of thought and feeling, which,

though very limited and imperfect, still answers many important purposes, and contributes materially to the happiness and preservation of species. Thus birds which congregate and which live in society have usually a regular watch stationed in some commanding situation, whose note of alarm is understood by the whole community. Of the truth of this observation, Fieldfares and Rooks furnish familiar and striking instances. The shrill call of the Swallow, the harsh scream of the Jay, and the petulant cries of the various species of Titmouse likewise intimate the approach of an enemy. The reiterated cackle of the Domestic Hen after she has laid speedily announces the joyful event; her cluck indicates that she has become the mother of a family; by a peculiar call she informs her brood whenever she discovers any thing suitable for food; and her shriek is a warning against impending danger. What is usually called the prating of poultry is expressive of satisfaction and complacency: but it is needless to multiply examples or to insist further on the many sueful purposes to which a familiarity with the language of birds may be rendered subservient. It will suffice to remark that this knowledge supplies the means of making fresh discoveries, of correcting numerous errors, and of removing many of those doubts and difficulties which have arisen from the great similarity of some species, and the peculiarities incidental to age, sex, and a change of food or climate in others, without placing

the observer under the painful necessity of destroying life—a recommendation which will be duly appreciated by every person possessed of a humane disposition and a reflecting mind.

Having endeavoured in these few preliminary observations to point out the great importance of attending to the notes of birds, I shall now proceed to an inquiry into their origin—an inquiry well calculated to exercise the skill of the experimentalist and the ingenuity of the speculative philosopher, though to the generality of mankind it may seem trivial and of little moment.

The only author that I am acquainted with who has treated this curious subject at any length is the Honourable Daines Barrington, in an essay entitled "Experiments and Observations on the Singing of Birds," published in the second part of the sixty-third volume of the 'Transactions of the Royal Society;' and as the experiments there detailed appear to be imperfect and unsatisfactory, and the conclusions drawn from them hasty, unwarranted, and contrary to common experience, and more especially as this author is generally referred to by our cyclopædists *, and as his opinions seem to be finding their way into modern works of respectability, where they are quoted as established facts which do not admit of a doubt †,

* See the 'Encyclopædia Britannica,' art. "Singing," and Rees's 'Cyclopædia,' art. "Song."

† See Bingley's 'Animal Biography,' vol. ii. pp. 166, 167.

it was thought that an examination of his method of investigation would be useful in exposing its insufficiency, and the consequent looseness of the arguments founded upon it; while the institution of a less exceptional course of experiments, it was hoped, might dissipate much of the obscurity in which this intricate question is at present involved. In what degree these expectations have been realized remains to be shown.

Mr. Barrington informs us that his experiments were principally made with young Linnets, which were fledged, and nearly able to leave the nest; and the reasons assigned for this selection are, that birds of this species are docile and possess great powers of imitation, and that the cocks are easily distinguished from the hens at an early period. These nestling Linnets were educated under singing birds of various kinds; and it appears that, instead of having the Linnet's notes, they learned those of their respective instructors, to which they adhered almost entirely. In some instances, to be sure, the nestlings retained the call of their own species, which, as they were three weeks old when taken from the nest, it is supposed they had learned from their parents; and not unfrequently, when they had opportunities of hearing several species, they borrowed from more than one, and their songs became mixed *.

* The reason given by Mr. Barrington for the steady adherence of birds in a wild state to their own songs is, that they

To be certain that nestlings will not have even the calls of their species, Mr. Barrington remarks that they should be taken when only a few days old. He then proceeds to notice instances of a Linnet and a Goldfinch taken at this early period, which came under his observation, acknowledging at the same time his own inability to rear birds of so tender an age. The first, he states, "belonged to Mr. Matthews, an apothecary at Kensington, which, from a want of other sounds to imitate, almost articulated the words 'pretty boy,' as well as some other short sentences;" and the owner assured him that it had neither the note nor call of any bird whatsoever. The Goldfinch had acquired the song of the Wren, without appearing to have a note or even the call of the Goldfinch.

From these experiments and observations, of which I have given a concise, but, I trust, impartial account, Mr. Barrington was led to conclude that "notes in birds are no more innate than language is in man, but depend entirely upon the master under which

attend to the instructions of the parent birds only, disregarding the notes of all others. That young birds receive instructions in singing from the old ones, appears to be a notion of great antiquity (*vide* Aristot. 'Histor. Animal.' lib. iv. cap. ix.; Plinii 'Histor. Natural.' lib. x. cap. xxix.). The celebrated Count Buffon seems to have entertained a similar opinion (see his 'Histoire Naturelle des Oiseaux,' tome cinquième, p. 47). Darwin also, in 'Zoonomia,' vol. i. p. 155, lends it the sanction of his authority.

they are bred, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing." I am not aware, however, that he has brought forward a single fact from which such an inference can be fairly deduced. The main tendency of his researches is merely to prove (what was before perfectly well known) that some birds have very extraordinary powers of imitation, and may be taught, when young, to sing the notes of other species, whistle tunes, or even pronounce a few words. If his remarks on this subject contain any novelty, it is that birds so educated sometimes remain satisfied with these imitations, never blending any of their own notes with them; and, indeed, on this solitary circumstance, slight and inconclusive as it is, the entire weight of his argument is rested. The instances of the Goldfinch acquiring the song of the Wren, and of Mr. Matthews's Linnet learning to articulate one or two short sentences, without having even the calls of their species, which this author seems to think so decisive, prove no more than his own experiments, which, as they were made for the most part with birds remarkable for their imitative powers, were certainly by no means well adapted to his purpose. As for the Goldfinch, Mr. Barrington heard it only once, and then but for a short time; and that no dependence could be placed on any report of the people to whom it belonged, is evident from their supposing that it sang its own notes. These are circumstances

which powerfully tend to invalidate almost every thing of importance that has been advanced respecting this bird.

In order to ascertain whether nestlings, when taken very young, will or will not have the calls and songs of their species, they should be kept in situations where they have no opportunity of learning any sounds which they may substitute for them; but this, I believe, has never yet been attempted.

I have already asserted that Mr. Barrington's conclusions are contrary to common experience. I shall now endeavour to establish this charge.

It is well known to most persons who have the care and management of poultry that Ducks, Guinea-fowls, &c., hatched under the Domestic Hen, and Domestic Fowls hatched under Turkeys, have the calls and habits peculiar to their species. That this is the case also with Pheasants and Partridges, brought up under similar circumstances, I have had frequent opportunities of observing. It is a matter of universal notoriety likewise that all Cuckoos of the species *canorus*, though hatched and reared by birds of various descriptions, have constantly their proper calls*. These

* Mr. Barrington will not allow that the well-known cry of the Cuckoo is a song, because it does not happen to accord with the conditions of his arbitrary definition, though to the bird it answers every purpose of a song, as well as the more elaborate effusions of the Nightingale and Sky-Lark. Mr. Barrington defines a bird's song to be a succession of three or more different notes,

facts, one would suppose, were quite sufficient to convince the most prejudiced that birds do not always acquire the calls and notes of those under which they are bred. But perhaps it may be urged that Ducks, Guinea-fowls, Pheasants, and Partridges are probably incapable of learning the calls of Domestic Fowls, that Domestic Fowls, in their turn, may be incapable of acquiring the call of the Turkey, and that the Cuckoo appears to be very poorly qualified for imitating the notes of its foster-parents. Still I must contend that the incapacity of those birds has never been proved; and even if it had, it would afford no explanation of the manner in which they become acquainted with their own respective calls. According to Mr. Barrington's theory they ought to be mute, or at least should have such notes only as they have been able to pick up casually, which, of course, would possess little or no resemblance.

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which are continued without interruption during the same interval as a musical bar of four crotchets in an adagio movement, or whilst a pendulum swings four seconds; which necessarily excludes the Chaffinch, Redstart, Hedge-Warbler, Yellow Wren, and some others, which have always been accounted birds of song, as well as the Cuckoo, from any pretensions to the title. Perhaps it would be more natural, and certainly less exclusive, to apply the term song to those notes which are peculiar to the males; yet this definition would admit the Peacock and Turkey into the catalogue of Singing Birds; and the hideous scream of the one and the ludicrous gobble of the other are certainly any thing but musical.

From these and similar observations I have long been thoroughly convinced myself that the calls of birds, which seem to be the simplest expressions of their sensations, are natural, not acquired; and in order to determine whether this is the case with their songs also, which are generally much more complex, and, consequently, have the appearance of being more artificial, the following experiments were made.

In the summer of 1822 I procured three young Greenfinches (a cock and two hens), which, as they did not see till the fourth day after they were taken from the nest, must then have been only two days old *.

These birds were reared by hand, in a house situated in the town of Manchester, where they had no opportunity of hearing the notes of any bird, except, perhaps, the occasional chirping of Sparrows; nevertheless they had all their appropriate calls, and the cock bird had the song peculiar to its species.

It was hoped, at the time, that this experiment would be considered sufficiently decisive; but recollecting that some persons, for the sake of showing their ingenuity in raising objections, might say that these birds remembered the notes of their parents, which they imitated as soon as they had acquired

* From numerous observations which I have made, it appears that young birds usually begin to see about the sixth day after they are hatched.

the power, and being willing to remove every circumstance on which the most fastidious inquirer could fix a doubt, I placed the eggs of a Redbreast in the nest of a Chaffinch, and removed the eggs of the Chaffinch to that of the Redbreast, conceiving that if I was fortunate in rearing the young, I should, by this exchange, insure an unexceptionable experiment, the result of which must be deemed perfectly conclusive by all parties. In process of time these eggs were hatched, and I had the satisfaction to find that the young birds had their appropriate chirps*.

When ten days old they were taken from their nests, and were brought up by hand, immediately under my own inspection, especial care being taken to remove them to a distance from whatever was likely to influence their notes. At this period an unfortunate circumstance, which it is needless to relate, destroyed all these birds except two (a fine cock Redbreast and a hen Chaffinch), which, at the expiration of twenty-one days from the time they were hatched, commenced the calls peculiar to their species. This was an important point gained, as it evidently proved that the calls of birds, at least, are instinctive; and that, at this early age, ten days are not sufficient to enable nestlings to acquire even the calls of those

* Mr. Barrington defines the chirp to be the first sound a young bird utters as a cry for food. It consists of a single note, repeated at short intervals, and is common to nestlings of both sexes.

under which they are bred, thus clearly establishing the validity of the first experiment made with the young Greenfinches. Shortly after, the Redbreast began to record*, but in so low a tone that it was scarcely possible to trace the rudiments of its future song in those early attempts. As it gained strength and confidence, however, its native notes became very apparent, and they continued to improve in tone till the termination of July, when it commenced moulting, which did not, as was expected, put a stop to its recording †. About the middle of August it was in deep moult, and by the beginning of October had acquired most of its new feathers. It now began to execute its song in a manner calculated to remove every doubt as to its being that of the Redbreast, had any such previously existed ‡; its habits also

* The first endeavours of a young bird to sing are termed recording.

† The important operation of moulting undoubtedly affects the singing of wild birds very considerably, and may, perhaps, be a principal cause of their silence in the month of August. The London bird-catchers are well aware of the advantages of occasioning their call-birds to moult prematurely, which by this expedient are brought into full song while other birds of their species are nearly mute. For an account of the manner in which this is effected, see Pennant's 'British Zoology,' vol. ii. p. 332.

‡ Montagu, in the Introduction to the 'Ornithological Dictionary,' p. 29, states, in a note, that "a Goldfinch, hatched and fostered by a Chaffinch, retained its native notes," but does not give any further particulars respecting this bird.

were as decidedly characteristic as its notes; and I am the more particular in noticing this latter circumstance, because the peculiar habits of birds are quite as difficult to account for as the origin of their songs*. Thus it appears from this satisfactory experiment, which was conducted with the utmost care, that, contrary to Mr. Barrington's opinion, the notes of birds, which probably consist of those sounds that their vocal organs are best adapted to produce, are perfectly instinctive †.

* Several birds sing in the night, and some warble as they fly. The Titlark uses particular notes in ascending and descending, and the song of the Whitethroat is accompanied with strange gesticulations. Larks and Wagtails run, Finches and Buntings hop, nearly the whole of the Gallinaceous and Pie tribes and many species of Water-fowl walk, and Woodpeckers climb. The Sparrow, Sky-Lark, and most of the Gallinæ are pulveratrices; and the Kestril, when it hovers, may be distinguished from every other British Falcon by the fanning-motion of its wings. Peculiarities in the modes of flight and nidification of various species are equally remarkable and worthy of notice; but, as they are foreign to the present subject, I shall not now dilate upon them.

† Since writing the above, I have met with the following general assertion in the 'Physiognomical System of Drs. Gall and Spurzheim,' by J. G. Spurzheim, M.D., second edition, pp. 194, 195:—"Singing birds, moreover, which have been hatched by strange females, sing naturally, and without any instruction, the song of their species as soon as their internal organization is active. Hence the males of every species preserve their natural song, though they have been brought up in the society of individuals of a different kind." This inference, I have been recently

Having shown that the notes of birds are natural, or, in other words, that they do not depend upon any previous instruction, it follows that they must furnish the attentive ornithologist with an excellent method of distinguishing species under all the various circumstances which are liable to affect their plumage; though it must be observed that the great similarity so evident in the songs of birds of the same species is more in tone and style than in the individual notes of which they are composed*.

I shall here remark that it is highly probable that no bird, in a wild state, ever borrows the notes of others, or becomes a mocker. I am well aware that several of our native birds, as the Pettychaps and Sedge-Warbler, have usually been termed Mocking-Birds; but this is certainly improper; as they constantly use their own natural notes, and no others, they do not at all merit this appellation. The fine strain of the first has been thought to bear a striking resemblance to those of the Swallow and Blackbird. This, however, must be entirely imaginary, as it is totally different from them in manner and notes. If it be possible to trace any similarity between them, it will be found to consist in tone merely. The song

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assured by Dr. Spurzheim, was deduced from carefully conducted experiments made by Dr. Gall.

* Birds of the same species do not always deliver their notes exactly in the same order of succession; neither do they uniformly use precisely the same notes.

of the Sedge-Warbler is wonderfully varied, and appears to be chiefly composed of passages borrowed from the songs of the Sky-Lark, Titlark, Whitethroat, Whinchat, Lesser Redpole, Swallow, &c. Now if any bird is entitled to the epithet of mocker, surely it is this; yet these resemblances are common to the songs of the whole species, which inhabits situations very unsuitable for acquiring some of them. In short, these fancied imitations are not studied, but purely accidental, consisting of their own notes *ab initio.*

The singing of birds has been very generally attributed to the passion of love, and a desire of pleasing their mates.

> "'Tis love creates their melody, and all
> This waste of music is the voice of love;
> That even to birds and beasts the tender arts
> Of pleasing teaches"*.

Thus the great poet of nature elegantly expresses the idea. This opinion, however, does not appear to be well founded; their language of love, their amorous strains, consist of low, intermitted tones, accompanied with ludicrous gesticulations, and are altogether different from their ordinary songs, which seem to be occasioned by an exuberance of animal spirits, arising from an abundance of nourishing food and an increase of temperature, and by a spirit of emulation and rivalry among the males. In confirmation of

* Thomson's 'Seasons,' "Spring."

what is here advanced, I shall observe that I have known many instances of birds having nests after they have entirely ceased singing, and that some species, as the Wood-Lark, Redbreast, Wren, and Dipper, sing long after they have done breeding. Caged birds also continue in song much longer than birds at large, though they have no mates to solace and amuse; and it is remarkable that almost any kind of shrill continued noise is sufficient to stimulate them to sing. That birds of the same species distinguish each other by their notes better than by any other circumstance, and that the songs of the males serve to direct the females where to seek their society, as Montagu has suggested, appears to me highly probable; but I must differ from this ingenious naturalist when he asserts that love is the sole cause of their songs*. In support of this opinion he states that the males of our Warblers, before they pair in spring, sing almost incessantly and with great vehemence, that from the time of pairing till the hens begin to sit they are neither so vociferous nor so frequently heard as before, that during the time of incubation their songs are again loud, but not so reiterated as at the first, and that so soon as the young are extruded from the eggs they cease singing entirely†; but it

* This he does, in effect, in the Introduction to the 'Ornithological Dictionary,' p. 28 and following.

† See the Introduction to the 'Ornithological Dictionary,' pp. 30, 31.

may be remarked that if they are not heard so frequently and earnestly after pairing as before, most probably it is because they are occupied in attending to the females; and I have already observed that their amatory notes, which they chiefly use at this period, are totally different from their ordinary songs. When the hens are sitting, or by any accident happen to be separated from their mates, the attention of the latter is much less engrossed; their notes of love are suspended, and their customary strains renewed. It is a very mistaken notion of Montagu that the songs of these birds cease immediately when their eggs are hatched, as, in numerous instances, it is notorious that they continue even for some time after the young have left the nest. Surely it is needless to insist that it cannot be love which prompts the young males to attempt their songs so soon as they are known to do*; besides, it has been shown that when educated early under other species, they sometimes possess their notes exclusively, which would hardly be the case if love is their only motive for singing.

For the information of those persons who may wish to be acquainted with the Singing Birds found in the neighbourhood of Manchester, I subjoin the following catalogue.

* Young birds frequently begin to practise their songs when only a month old.

A Catalogue of Singing Birds heard in the neighbourhood of Manchester, with the periods at which they commence and discontinue their Songs, taken at a mean of eleven years' observations, commencing with 1818 *and terminating with* 1828.

Birds.	Commence singing.	Cease singing.
Redbreast (*Sylvia rubecula*)	Jan. 2	Dec. 30
Wren (*Sylvia troglodytes*) *	„ 3	„ 25
Missel-Thrush (*Turdus viscivorus*) †	„ 24	June 5
Throstle (*Turdus musicus*)	„ 27	Aug. 8
Hedge-Warbler (*Accentor modularis*)	Feb. 1	July 21
Sky-Lark (*Alauda arvensis*)	„ 5	„ 16
Chaffinch (*Fringilla cœlebs*)	„ 11	„ 8
Starling (*Sturnus vulgaris*)	„ 16	June 6
Blackbird (*Turdus merula*)	March 5	July 19
Titlark (*Anthus pratensis*)	„ 19	„ 18
Wood-Lark (*Alauda arborea*)	„ 20	Oct. 23
Greenfinch (*Fringilla chloris*)	„ 26	Aug. 17
Wheatear (*Saxicola œnanthe*)	April 9	June 19
Linnet (*Fringilla cannabina*)	„ 11	July 12
Yellow Wren (*Sylvia trochilus*)	„ 12	Aug. 20
Redstart (*Sylvia phœnicurus*)	„ 13	July 17
Lesser Field-Lark (*Anthus arboreus*)	„ 14	„ 9
Lesser Redpole (*Fringilla linuria*)	„ 15	„ 22
Goldfinch (*Fringilla carduelis*)	„ 15	„ 3
Whinchat (*Saxicola rubetra*)	„ 26	„ 9
Swallow (*Hirundo rustica*)	„ 26	Sept. 21
Blackcap (*Sylvia atricapilla*)	„ 28	July 17
Whitethroat (*Sylvia cinerea*)	„ 29	„ 20
Stonechat (*Saxicola rubicola*)	„ 30	„ 3
Lesser Whitethroat (*Sylvia curruca*)	May 1	„ 12
Sedge-Warbler (*Sylvia phragmitis*) ‡	„ 3	„ 23
Pettychaps (*Sylvia hortensis*)	„ 6	„ 14
Red-backed Shrike (*Lanius collurio*)	„ 20	„ 17

* The Redbreast and Wren sing nearly at all times of the year, except when moulting and during severe frost; and several species of birds which cease singing about the latter end of July or the beginning of August are sometimes heard again in autumn, when their songs are generally feeble, imperfect, and of short continuance, like the early efforts of our Warblers in spring.

† The Missel-Thrush is the largest British bird of song.

‡ In this catalogue I have omitted the Yellow Bunting, Reed-Bunting, Golden-crested Wren, Wood-Wren, and some others, which have not uniformly been accounted Singing Birds.

It would be difficult, nay impossible, to convey a distinct idea of the songs of these birds by any verbal description; indeed the delightful associations they excite, with the adventitious circumstances of time, distance, situation, &c., so greatly influence their effect, that even the best imitations are utterly inadequate to produce any thing equal to it.

Mr. Barrington, in his essay, has attempted to construct a Table by which the comparative merits of British Singing Birds may be examined; but as he does not appear to have formed a correct estimate of the songs of some species, and as his Table is inaccurate in other respects, besides being too limited, I have endeavoured to supply one (p. 47) which will be more comprehensive, and, I trust, less objectionable, making, as he has done, the number 20 the point of absolute perfection.

This long catalogue of birds, most of which, it appears, are to be found in the immediate neighbourhood of Manchester, composes the feathered choir which enlivens the pastoral scenery of England with a rich and varied melody of song, which probably is not surpassed in any known part of the globe.

Birds.	Mellowness.	Sprightliness.	Plaintiveness.	Compass.	Execution.
Nightingale (*Sylvia luscinia*)	19	14	19	19	19
Redbreast (*Sylvia rubecula*)	13	8	14	16	17
Sky-Lark (*Alauda arvensis*)	4	19	4	17	15
Blackcap (*Sylvia atricapilla*)	14	12	12	10	8
Pettychaps (*Sylvia hortensis*)	14	6	14	10	9
Wood-Lark (*Alauda arborea*)	18	2	17	8	6
Linnet (*Fringilla cannabina*)	10	13	9	9	11
Sedge-Warbler (*Sylvia phragmitis*)*	2	16	2	18	10
Goldfinch (*Fringilla carduelis*)	4	14	4	9	11
Throstle (*Turdus musicus*)	3	12	2	10	5
Blackbird (*Turdus merula*)	8	2	7	5	5
Lesser Field-Lark (*Anthus arboreus*)	8	5	6	4	4
Yellow Wren (*Sylvia trochilus*)	6	5	6	4	4
Chaffinch (*Fringilla cœlebs*)	2	16	1	4	4
Wren (*Sylvia troglodytes*)	1	19	0	4	4
Pied Flycatcher (*Muscicapa luctuosa*)	5	5	5	4	4
Greenfinch (*Fringilla chloris*)	5	3	4	4	3
Dipper (*Cinclus aquaticus*)	4	5	3	4	3
Hedge-Warbler (*Accentor modularis*)	3	4	3	4	4
Missel-Thrush (*Turdus viscivorus*)	3	4	2	5	3
Swallow (*Hirundo rustica*)	3	6	2	3	3
Red-backed Shrike (*Lanius collurio*)	2	4	2	4	2
Starling (*Sturnus vulgaris*)	4	2	2	4	2
Titlark (*Anthus pratensis*)	2	3	2	2	2
Shore-Lark (*Anthus aquaticus*)	2	2	2	2	2
Whitethroat (*Sylvia cinerea*)	1	4	0	4	3
Redstart (*Sylvia phœnicurus*)	1	4	0	3	3
Whinchat (*Saxicola rubetra*)	1	3	1	3	2
Siskin (*Fringilla spinus*)	1	4	0	3	2
Lesser Redpole (*Fringilla linaria*)	1	4	0	3	2
Wheatear (*Saxicola œnanthe*)	1	3	0	3	2
Stonechat (*Saxicola rubicola*)	1	3	0	2	2
Lesser Whitethroat (*Sylvia curruca*)	1	2	0	2	2
Dartford Warbler (*Sylvia provincialis*)†					
Reed-Wren (*Sylvia arundinacea*)					

* Mr. Barrington has inserted the Chaffinch, Hedge-Warbler, and Reed-Sparrow in his table, which (according to his definition of a bird's song) ought not to have been admitted; indeed the notes of the Reed-Sparrow are so mean that I am inclined to believe that he has attributed the song of the Sedge-Warbler to this species, especially, as he remarks in a note, that it sings in the night, an error by no means uncommon among ornithologists; yet, if this be the case, he has greatly underrated it; for though harsh in tone and hurried in manner, and though the same note is repeated frequently in succession, it certainly possesses great variety, and is, upon the whole, rather agreeable.

† I have included the Dartford Warbler and the Reed-Wren on the authority of Montagu (see the 'Ornithological Dictionary' and Supplement), but I possess no means of estimating the songs of these species, having never heard them.

The following poetical description of the vernal chorus, with which I shall close these observations, is from Thomson's 'Seasons,' "Spring":—

"Up springs the Lark,
Shrill voic'd, and loud, the messenger of morn;
Ere yet the shadows fly, he mounted sings
Amid the dawning clouds, and from their haunts
Calls up the tuneful nations. Every copse
Deep-tangled, tree irregular, and bush
Bending with dewy moisture, o'er the heads
Of the coy quiristers that lodge within,
Are prodigal of harmony. The Thrush
And Wood-Lark, o'er the kind contending throng
Superior heard, run through the sweetest length
Of notes; when listening Philomela deigns
To let them joy, and purposes in thought
Elate, to make her night excel their day.
The Blackbird whistles from the thorny brake;
The mellow Bullfinch answers from the grove:
Nor are the Linnets, o'er the flowering furze
Pour'd out profusely, silent. Join'd to these,
Innumerous songsters, in the freshening shade
Of new-sprung leaves, their modulations mix
Mellifluous. The Jay, the Rook, the Daw,
And each harsh pipe, discordant heard alone,
Aid the full concert; while the Stock-dove breathes
A melancholy murmur thro' the whole."

OBSERVATIONS ON THE CUCKOO.

DURING a period of more than two thousand years, from the time of Aristotle (the father of Natural History) to the year 1788, when the excellent observations of Dr. Jenner, so justly celebrated for the introduction of vaccination, were published in the 'Transactions of the Royal Society' *, the history of the Cuckoo, if it deserved the appellation, consisted of a tissue of extravagant fables, very sparingly interspersed with facts. It will not be necessary to particularize the many fanciful conjectures transmitted to us by the ancients respecting this bird, as they have been repeatedly noticed by authors of eminence, and are sufficiently well known to the classical ornithologist. It may be observed, however, that so profound has been the veneration of succeeding ages for the opinions of antiquity, and so unbounded the confidence in the accuracy of those collected by Aristotle on this particular subject, that, notwithstanding the great absurdity of some of them, they long continued to

* Vol. lxxviii. pt. 2.

maintain the reputation they had acquired, a few slight additions and corrections only having been made by more modern writers till the publication of Dr. Jenner's interesting discoveries; indeed almost the only facts in the obscure history of this singular species which seem to have been known with any tolerable degree of certainty, even towards the close of the eighteenth century, were that Cuckoos appear and disappear periodically, that the call from which they take their name is peculiar to the male, that the female lays her eggs in the nests of other birds, that those birds carefully bring up the young Cuckoo (which has a weak, plaintive chirp, and is very different in plumage from adults), and that it is generally observed to be the sole occupier of the nest. In this state the history of the Cuckoo remained, when Dr. Jenner, at the request of Mr. John Hunter, undertook to investigate its habits and economy; and in the course of his researches, which were conducted with great care and assiduity, he discovered a number of curious facts, scarcely less wonderful than the marvellous but visionary speculations of the ancients themselves. The following brief abstract will serve to convey some idea of what his skill and industry effected.

Dr. Jenner informs us that the first appearance of Cuckoos in Gloucestershire, where his observations were made, is about the 17th of April. The call of the male, which is well known, soon proclaims his

arrival; that of the female is widely different, and has been so little attended to, that few persons are acquainted with it; it is thought, however, to bear some resemblance to the cry of the Little Grebe.

Unlike the generality of birds, Cuckoos do not pair; and as their eggs are seldom met with till about the middle of May, it is supposed that the females do not begin to lay till some weeks after their arrival. Cuckoos deposit their eggs in the nests of a great variety of small birds, intrusting them to the care of the Hedge-Warbler, Pied Wagtail, Titlark, Yellow Bunting, Greenfinch, Whinchat, &c. Among these they usually select the first three, but show a much greater partiality to the Hedge-Warbler than to any of the rest. The Hedge-Warbler commonly takes up four or five days in laying her eggs, and during this time (generally after she has laid one or two) the Cuckoo contrives to deposit hers among the rest. This intrusion often occasions some discomposure; for the Hedge-Warbler, at intervals, whilst she is sitting, not unfrequently throws out some of her own eggs, and sometimes injures them in such a way that they become addled; however, she is rarely observed to throw out or injure that of the Cuckoo. She continues to sit the same length of time as if no foreign egg had been introduced, the Cuckoo's requiring no longer incubation than her own—nay, it frequently happens that it is hatched first. The Titlark is often selected by the Cuckoo to take charge of its off-

spring, but, as it is a bird less familiar than many which have been mentioned, its nest is not so often discovered.

The young Cuckoo, soon after it is extricated from the egg, commences the extraordinary practice of turning out its companions, which are usually left to destruction. The mode of accomplishing this is very curious: with the assistance of its rump and wings it contrives to get a young bird upon its back, and making a lodgment for the burden by elevating its pinions, clambers backward with it up the side of the nest till it reaches the top, where, resting for a moment, it throws off its load with a jerk, and quite disengages it from the nest. It remains in this situation a short time, feeling about with the extremities of its wings as if to be convinced that the business is properly executed, and then drops into the nest again. It frequently examines, as it were, an egg or nestling with the ends of its wings before it begins its operations; and the nice sensibility which these parts appear to possess seems sufficiently to compensate for the want of sight, of which sense it is at first destitute. It is wonderful to see the extraordinary exertions of the young Cuckoo, when it is two or three days old, if a bird be put into the nest which is too weighty for it to lift out. In this state it seems ever restless and uneasy; but the disposition for turning out its companions continues to decline from the time it is two or three till it is about twelve days old,

when it usually ceases; indeed the disposition for throwing out the egg appears to cease a few days sooner, for the young Cuckoo, after it has been hatched nine or ten days, will frequently remove a nestling which has been placed in the nest with it, when it will suffer an egg, put there at the same time, to remain unmolested. The singularity of its shape is well adapted to these purposes; for, different from other newly hatched birds, its back, from the scapulæ downwards, is very broad, with a considerable depression in the middle, which seems formed by nature for the design of giving a more secure lodgment to any object that the young Cuckoo may be desirous of removing from the nest. When it is about twelve days old, this cavity is quite filled up, and then the back assumes the shape common to nestling birds in general. The same instinctive impulse which directs the Cuckoo to deposit her eggs in the nests of other birds, directs her offspring to throw out the eggs and young of the owners of the nests. The scheme of nature would be incomplete without it; for it would be extremely difficult, if not impossible, for the small birds, destined to find support for a young Cuckoo, to find it for their own young ones also, after a certain period; nor would there be room for the whole to inhabit the nest.

The eggs of the Cuckoo are remarkably small in proportion to the size of the bird; they also vary considerably in size, weight, and colour. It some-

times happens that two are deposited in the same nest; and Cuckoos' eggs are frequently hatched in the nests of other birds, after the birds which laid them have disappeared.

There is certainly, Dr. Jenner observes, no reason to be assigned, from the formation of the Cuckoo, why, in common with other birds, it should not perform the several offices of nidification, of incubation, and of rearing its young. It is in every respect perfectly formed for collecting materials and constructing a nest; neither its external shape nor internal structure prevent it from hatching its eggs; nor is it by any means incapacitated for bringing food to its young. To what cause then, he inquires, must we attribute the singularities of this bird? May they not be owing to the following circumstances?—The short residence it is allowed to make in the country where it is destined to propagate its species, and the call which nature has upon it, during that short residence, to produce a numerous progeny. The Cuckoo's first appearance in Gloucestershire is about the middle of April, commonly on the 17th; its egg is not ready for incubation till some weeks after its arrival, seldom before the middle of May; a fortnight is taken up by the sitting bird in hatching the egg; the young bird generally continues three weeks in the nest before it flies, and the foster-parents feed it more than five weeks after that period; so that, if a Cuckoo should be ready with an egg much sooner than the time

pointed out, not a single nestling, even of the earliest, would be fit to provide for itself, before its parent would be instinctively directed to seek a new residence, and would be thus compelled to abandon its young one; for old Cuckoos take their final leave of this country in the first week of July.

If nature had allowed the Cuckoo to stay here as long as some other Migratory Birds which produce a single set of young ones (as the Swift or Nightingale for example), and had allowed it to rear as large a number as any bird is capable of bringing up at one time, these might not have been sufficient to answer her purpose; but by sending the Cuckoo from one nest to another, it is reduced to the same state as the bird whose nest is daily robbed of an egg, in which case the stimulus for incubation is suspended. Of this we have a familiar example in the common Domestic Fowl. That the Cuckoo actually lays a great number of eggs, dissection seems to prove very decisively. Upon comparing the ovarium, or racemus vitellorum, of a female Cuckoo, killed just as she had begun to lay, with that of a pullet killed just in the same state, no essential difference appeared: the uterus of each contained an egg perfectly formed and ready for exclusion; and the ovarium exhibited a large cluster of eggs gradually advanced from a very diminutive size to the greatest the yolk acquires before it is received into the oviduct. The appearance of one killed on the 3rd of July was very different.

In this a great number of the membranes which had discharged yolks into the oviduct might be distinctly traced, and one of them appeared as if it had parted with a yolk on the preceding day. The ovarium still exhibited a cluster of enlarged eggs, but the most forward of them was scarcely larger than a mustard-seed.

It plainly appears, Dr. Jenner remarks, that birds can keep back or bring forward their eggs (under certain limitations) at any time during the season appointed for them to lay; but the Cuckoo, not being subject to the common interruptions, goes on laying from the time she begins till the eve of her departure from this country; for, although old Cuckoos generally take their leave in the first week of July, yet instances are not wanting of eggs having been hatched so late as the middle of that month.

Among the many peculiarities of the young Cuckoo, there is one which shows itself very early. Long before it leaves the nest it frequently, when irritated, assumes the manner of a bird of prey, looks ferocious, throws itself back, and pecks at any thing presented to it with great vehemence, often at the same time making a chuckling noise like a young Hawk. Sometimes, when disturbed in a smaller degree, it makes a kind of hissing noise, accompanied with a heaving motion of the whole body.

Its chirp is plaintive, like that of the Hedge-Warbler; but the sound is not acquired from the

foster-parent, as it is the same whether it be reared by the Hedge-Warbler or by any other bird. It never acquires the adult note during its stay in this country.

The growth of the young Cuckoo is very rapid; and as it is fed for a long period by the small birds which have the care of it, they frequently have to perch on its back or half-expanded wing, in order to gain a sufficient elevation to put the food into its mouth.

There seems to be no precise time fixed for the departure of young Cuckoos. Probably they go off in succession as soon as they are capable of taking care of themselves; for though they stay here till they become nearly equal in size and growth of plumage to old ones, yet in this very state the care of their foster-parents is not withdrawn from them. If they did not go off in succession, it is probable that we should see them in large numbers by the middle of August; for as they are to be found in great plenty when in a nestling state, they must then appear very numerous, since all of them must have quitted the nest before that time; but this is not the case, for they are not more numerous at any season than the parent birds are in the months of May and June.

Such are the most important particulars which have resulted from Dr. Jenner's well-conducted inquiry; and to the accuracy of the greater part of them I

can unite my testimony with that of others, though, in a few instances, our opinions do not entirely coincide.

Dr. Jenner states that Cuckoos continue to lay regularly from the exclusion of the first egg to the time of their departure, and supposes that they are enabled to do so by intrusting the care of their progeny to strangers, being placed by this circumstance, he observes, in a similar situation to the bird whose nest is daily robbed of an egg. Now if Dr. Jenner means to assert that birds, during the breeding-season, can produce eggs at will, and that they may be excited to lay in succession many more than their usual number, by daily removing one from their nests, he is certainly mistaken: Colonel Montagu's experiments*, as well as my own, decidedly prove the contrary, both with regard to wild and domestic birds.

As Cuckoos deposit only a single egg in the same nest, they have been thought, by most persons, to lay no more than one. Dr. Jenner, on the contrary, supposes, from an examination of the ovary in a bird which had just commenced laying, and from having observed that Cuckoos' eggs are occasionally laid about the time that the old birds disappear, that they produce a large number. With due deference to such high authority as Dr. Jenner, I think there are suffi-

* 'Ornithological Dictionary,' Introduction, p. 10 and following.

cient reasons for believing that both these extremes are erroneous. According to Montagu*, whose opinion is founded on the dissection of breeding females, Cuckoos lay from four to six eggs; and this is probably near the truth. In females opened when they had just begun to lay, only four or five eggs were usually discovered that could possibly be laid in succession, from the smallest of which to what may be termed the secondary eggs there was a sudden break off, not a gradual decrease in size. The scarcity also of the eggs and young of this species, even in its favourite haunts, tends powerfully to confirm the opinion that Dr. Jenner has greatly overrated its fecundity †.

It is possible that those Cuckoos which arrive early may sometimes lay two sets of eggs during their stay with us; but then we may safely conclude that a considerable interval of time always elapses between the production of the first and second sets; and it is quite as probable that those eggs which are occasionally found in July should be laid by birds which arrive late, as by early-coming birds which produce

* 'Ornithological Dictionary,' Introduction, p. 8 and following.

† White Moss, a bog of considerable extent, situated about four miles to the N.E. of Manchester, is a very favourite resort of Cuckoos; yet the turf-cutters inform me that even in the most favourable seasons they never knew of more than five or six eggs belonging to this species in different nests at the same time.

more than one set of eggs; for Cuckoos come and go in succession, some individuals appearing three weeks, or even a month, before others; besides, it may frequently happen that many females have not an opportunity of forming a connexion with the other sex till long after their arrival: for though it is generally asserted that Cuckoos do not pair, and hence it may be inferred that the intercourse between the sexes must be greatly facilitated, yet the accurate observations of my friend R. G. Baker, Esq., certainly render this opinion doubtful. In the spring of 1823 he noticed that a pair of Cuckoos frequented the same spot for more than a fortnight, and were so jealous of the approach of any other bird of the same species, that they constantly united their efforts to drive away an intruder, and always with success. I may add that the male was distinguished from every other in the vicinity by the deepness of his note. This unquestionably looks like pairing, and should, at least, prevent a hasty decision on a point which deserves further investigation.

Colonel Montagu, from the extraordinary fact related by Dr. Jenner of two Hedge-Warbler's eggs, containing living fœtuses, having been found under a young Cuckoo about a fortnight old, and from the difficulty which he supposes Cuckoos would have in meeting with nests in a suitable state to receive their eggs, if they were compelled to lay them in regular succession, conjectures that, contrary to the generality

of birds, they have the power of retaining the egg in the uterus after it is perfected, and that while it remains there the embryo is progressively advanced towards maturity by the internal heat of the parent's body*. Now, without having observed a single circumstance in the whole course of my inquiries which at all tends to corroborate this opinion of Montagu's, I have discovered a curious fact which appears to render such a supposition altogether unnecessary. On the 5th of May, 1822, I saw a Cuckoo in the act of watching a pair of Titlarks construct their nest. The Larks had just commenced building, and did not seem to be at all disconcerted at the presence of the Cuckoo, which sat on the ground, about seven or eight yards from the spot, attentively observing them, and when disturbed flew away with great reluctance, and only to a short distance. This nest, which was on Kersal Moor, where the races are annually held, was too distant from my residence to permit me to examine it frequently, and to make such numerous and minute observations as I wished; but on the 12th of May I again visited it, in the confident expectation that it would contain a Cuckoo's egg, and I was not disappointed. I may further remark, in confirmation of this discovery, which, by exhibiting a curious and hitherto unnoticed instinctive propensity of this bird, forms an interesting addition to its history, that Cuckoos almost invariably deposit their

* 'Ornithological Dictionary,' Introduction, p. 15.

eggs in the nests of other birds as soon as those birds begin to lay—not unfrequently, indeed, immediately after the exclusion of the first egg; and Mr. Baker informs me that he saw the hen of that pair of Cuckoos which he observed so closely last spring fly directly to a Titlark's nest as to a place with which she was perfectly familiar, though he had never seen her there before; and after raising her head and looking round, as if to ascertain whether she was noticed or not, she went and deposited her egg in the nest before the Larks had begun to lay. From these circumstances, and from the direct evidence of my own senses, I consider this fact, then, as satisfactorily established; and it is of importance, inasmuch as it completely obviates a difficulty which has greatly perplexed modern ornithologists, and which chiefly induced Colonel Montagu to form his extraordinary but gratuitous opinion respecting the power of the Cuckoo to retain its egg till it meets with a nest in a suitable state to receive it.

Though Dr. Jenner enumerates a variety of small birds in whose nests Cuckoos deposit their eggs, yet he remarks that in Gloucestershire they give a decided preference to that of the Hedge-Warbler. In the neighbourhood of Manchester, where Titlarks are numerous, their nests are usually selected for that purpose, and perhaps would be so very generally were they equally abundant in all situations, as, from being built on the ground, they are much more

accessible to so large a bird as the Cuckoo than that of the Hedge-Warbler, which is frequently placed in close thorn-hedges or thick bushes. If Cuckoos laid in the nests of large birds, their young would not be able to dispossess their companions, and would probably soon perish for want of proper food.

It is now well known that Cuckoos, in proportion to their size, lay remarkably small eggs, which vary considerably both in magnitude and colour.

The following Table exhibits the mean weight of the Cuckoo and of several birds in whose nests it most frequently lays; also the mean weight of their eggs, with the ratio of the weight of each bird to that of its egg, omitting fractions :—

Birds.	Mean weight in grains.	Mean weight of their eggs in grains.	Ratio of birds to their eggs in weight.
Cuckoo	1925	55	35
Titlark	289	35	8
Lesser Field-Lark	354	37	9
Yellow Bunting	412	43	9
Hedge-Warbler	332	35	9
Pied Wagtail	333	37	9

If it be admitted, as I believe it safely may, that Cuckoos lay from four to six eggs, it will not be difficult to furnish data from which a rough estimate may be made of the mean annual destruction occasioned by young Cuckoos among small birds in England and Wales. Early in May, before Cuckoos have begun to breed, and before the foliage of forest-

trees has been sufficiently expanded to afford them shelter and concealment, I have known nine or ten of these birds come in an evening to roost among the evergreens in the plantations immediately adjoining our family residence; and as I am certain that all the Cuckoos belonging to the township of Crumpsall, in which it is situated, did not come to roost with us on those occasions, and as it is very probable that I did not see all which did come, I think, though the number of males is reported to exceed that of females, that four will not be considered a high average for the latter in Crumpsall, which contains 3,301,816 square yards, nor three too high as a general average for an equal area, since Dr. Jenner remarks that Cuckoos are numerous in Gloucestershire, and Colonel Montagu states that they are plentiful in Devonshire*; and I know, from my own observation, that they are much more abundant in many parts of Lancashire, Cheshire, Derbyshire, Staffordshire, Warwickshire, and also in Westmoreland and Cumberland, especially in the neighbourhood of the Lakes, than they are with us. I am informed likewise that they are very plentiful in Yorkshire and also in the principality of Wales. The mean number of eggs laid by those birds which are usually selected by the Cuckoo to provide for its progeny is five. Now, according to Pinkerton, the area of England and Wales is 49,450 square miles, which, reduced to square yards, gives

* 'Ornithological Dictionary,' Introduction, p. 10.

153,176,320,000. This, divided by 3,301,816 square yards (the area of the township of Crumpsall), and the quotient multiplied by 3 (the mean number of hen Cuckoos for every 3,301,816 square yards), gives 139,173 (the mean annual number of female Cuckoos that visit England and Wales), which, multiplied by 5 (the mean number of eggs laid by the Cuckoo), gives 695,865, the number of nestlings produced annually by the mean number of females; and this product multiplied by 5 (the mean number of eggs laid by those birds to whose care Cuckoos usually intrust their offspring) gives 3,479,325, the mean annual number of nestling birds destroyed by young Cuckoos in England and Wales. Enormous as this destruction appears to be, it is probably rather under than overrated, and when compared with that occasioned by Cuckoos in general, or by our British species alone in the various countries in which it breeds, it sinks into absolute insignificance.

The injuries which so frequently happen to the eggs of those birds in whose nests Cuckoos lay are occasioned, as I have often proved experimentally, by the sitting bird in attempting to accommodate herself to eggs of different sizes. If comparatively large and small eggs are placed in the same nest, some of the smaller ones are generally thrown out, or rendered addle, by the hen bird in endeavouring to arrange them so that she may distribute nearly an equal degree of warmth and pressure to all; but the larger

ones, which chiefly sustain her weight, and, consequently, are less liable to be moved, usually remain unmolested. When the eggs of birds are exchanged for others of a uniform magnitude, whether larger or smaller than their own, provided the difference is not so great as to occasion them to be forsaken, no disturbance ensues, whatever their colour may be, the change either not being perceived or totally disregarded; and the young, when extruded, are attended with the utmost care and solicitude.

Cuckoos generally use the precaution of waiting for the absence of small birds from their nests before they venture to lay in them: sometimes, however, their approach is perceived, when the owners immediately make every effort to repel them, but do not always succeed, as the following instance evinces. On the evening of the 24th of June, 1814, I saw a hen Cuckoo alight in a field of mowing grass, when a pair of Titlarks attacked it with such fury that they pulled several small feathers off it. Their loud cries and violent gesticulations attracted the notice of several people at work near the spot, who, by throwing stones at the Cuckoo, drove it to some distance; however, it soon returned, and, though repeatedly annoyed, persevered till it ultimately accomplished its purpose by laying in the nest of the Larks. As this bird was on the very eve of its departure (for I did not see a single old Cuckoo that year after the 25th of June), the case was an urgent one, and may account

for its unremitted exertions. This fact proves also how very late in the season Cuckoos' eggs are occasionally laid.

On the 30th of June, 1823, I took a young Cuckoo, which was hatched in a Titlark's nest, on White Moss, on the 28th, seven days after old birds had quitted that neighbourhood; and this nestling, while in my possession, afforded me an opportunity of contemplating at leisure the entire process of ejecting young birds and eggs from the nest, so minutely and accurately described by Dr. Jenner. I observed that this bird, though so young, threw itself backwards with considerable force when any thing touched it unexpectedly. It died on the 2nd of July, the fifth day after it was hatched, and then weighed 318 grains.

Intelligent ornithologists have denied or doubted the capability of young Cuckoos to eject the progeny of their foster-parents from the nest until they are a week or ten days old, and have acquired the use of their eyes. This incredulity can only be accounted for on the supposition that such observers have failed carefully to investigate the early economy of this species, which I have shown not only establishes the fact called in question, but likewise renders evident the unreasonableness of hastily rejecting phenomena which are extraordinary or anomalous as unworthy of belief, and of relying too exclusively on analogical reasoning in natural history.

Young Cuckoos are so very different from adults,

that they have been described by several authors as a distinct species. In the colours of their plumage, and in their eyes, they bear some resemblance to young Kestrils; while the old birds, in both these particulars, are very similar to the male Sparrow-Hawk after the third or fourth moult. As young Cuckoos do not acquire their mature plumage while they remain in this country, though they are frequently seen here in September, two months later than old birds, and as they are never found in their first feathers on their return in spring, they must moult during their absence, which clearly proves that they are migratory, as it is hardly possible that they should acquire fresh feathers in a state of torpidity. This fact is further corroborated by the early departure of the old birds, which takes place when the temperature is approaching the maximum for the year, and consequently when it is much higher than at the time of their arrival; and it is evident that they cannot become torpid with an increasing temperature: indeed the young birds, which stay so long after them, instead of displaying symptoms of debility and torpor, continue to advance progressively in growth and vigour. Cuckoos, at a mean of fifteen years' observations, appear in the neighbourhood of Manchester on the 20th of April, when the temperature of the air is 47° in the shade, and quit it on the 27th of June, when the temperature is 59°.

It has been asserted that Cuckoos sometimes incu-

bate their own eggs and bring up their own young; but all the instances brought forward in support of this opinion, except one, are totally undeserving of notice, and this might have been passed over without comment also if Dr. Darwin*, the Hon. Daines Barrington†, and the Rev. W. Bingley‡ had not seemed to consider it conclusive and incontrovertible. The circumstance is thus related by Darwin. "As the Rev. Mr. Stafford was walking in Glossop Dale, in the Peak of Derbyshire, he saw a Cuckoo rise from its nest. The nest was on the stump of a tree, that had been some time felled, among some chips that were in part turned grey, so as much to resemble the colour of the bird. In this nest were two young Cuckoos: tying a string about the leg of one of them, he pegged the other end of it to the ground, and very frequently for many days beheld the old Cuckoo feed these (her young) as he stood very near them." That Mr. Stafford must have been mistaken needs scarcely to be insisted on, since Dr. Jenner has shown that when two young Cuckoos happen to be hatched in the same nest, the stronger invariably turns out the weaker. The nest which Mr. Stafford found, from the number of young it contained, most probably belonged to a Goatsucker, as I know that this species, which seldom lays more than two or three eggs,

* 'Zoonomia,' vol. i. pp. 172, 173.

† 'Miscellanies,' p. 255.

‡ 'Animal Biography,' vol. ii. pp. 299, 300.

breeds in the neighbourhood of Glossop, and it might easily be mistaken for a Cuckoo by a person not very familiar with birds who had only an opportunity of observing it at a distance. If this gentleman had been a skilful ornithologist, would he not have endeavoured to remove every possibility of doubt in a matter which it is evident greatly excited his interest, by examining and describing the structure of the feet and bill of these young birds?

Male Cuckoos, a short time before they retire, entirely lose their cry, and this loss is generally preceded by stammering and a difficulty of utterance. Now as most of our Singing Birds become mute in autumn, solely from inability to continue their songs, as is manifest from their unavailing efforts to prolong them, whatever occasions their silence most probably occasions that of the Cuckoo also; and I conceive that an efficient cause will be found in the propagation of their species and in the decrease of their food, which, by relaxing the vocal organs, renders them incapable of obeying the dictates of the will. The well-known cry of the male Cuckoo is frequently heard in the night.

Various are the modes of accounting for the peculiarities of the Cuckoo adopted by different writers on the subject. Some, who have turned their attention particularly to the anatomy of this bird, think they have discovered a satisfactory reason for its not hatching its own eggs in the largeness and protu-

berance of its stomach, which, they hastily conclude, must render the act of incubation difficult, if not impracticable; but when we consider that several birds, as the Owl, Goatsucker, &c., whose stomachs are in those respects similar to that of the Cuckoo, do incubate their own eggs, the insufficiency of this imaginary cause will be very apparent.

Buffon supposes that female Cuckoos lay their eggs in the nests of other birds to prevent the males, which he states occasionally prey upon eggs, from destroying them*. The chief objection to this supposition arises from the deficiency of evidence in support of this charge brought against the males.

According to the 'Physiognomical System' of Drs. Gall and Spurzheim, Cuckoos transfer the care of their progeny to strangers in consequence of the imperfect development of certain cerebral organs, termed by those authors organs of constructiveness and philoprogenitiveness, whose functions are thus necessarily circumscribed. I shall not here discuss the merits of this system, which, notwithstanding the ridicule that is bestowed upon it, is at least entitled to a patient and candid investigation, but shall proceed to consider the reason assigned by Dr. Jenner for the singularities of the Cuckoo. This gentleman conjectures, as I have already stated, that the short stay which Cuckoos make in this country is the true reason why they do not bring up their own young, as

* 'Histoire Naturelle des Oiseaux,' tome sixième.

the parent birds would be impelled, by a desire to migrate, to quit their progeny before they were able to provide for themselves. This hypothesis, as regards the British species, certainly has an appearance of plausibility; yet the early departure of Cuckoos may result from their not having to provide sustenance for their young: in what degree it is applicable to foreign species, of which Dr. Latham, in his 'General History of Birds,' enumerates about 87, besides varieties, is an interesting inquiry which our present very imperfect knowledge of their habits and economy will not permit us to answer. Dr. Latham, indeed, does not particularize more than five or six species belonging to this extensive genus which lay in the nests of other birds, nor more than twice that number which bring up their own young; and of the manners and propensities of the rest we are almost entirely ignorant.

It is reported that the Cow-pen Bird (*Icterus pecoris*, Bonaparte), a species perfectly distinct from the Cuckoos, has many of their most remarkable peculiarities, intrusting the care of its offspring to strangers, and laying only one egg in the same nest.

Dr. Darwin, in 'Zoonomia,' maintains that the propensities of the Cuckoo to lay in the nests of other birds and to migrate are not instinctive, and goes so far as to reflect upon the reasoning-powers of those who entertain a contrary opinion. But the Doctor, though a profound scholar and a close observer of

nature, was not infallible; and it would be easy to point out numerous errors into which he has fallen in his very ingenious and amusing work, especially in the section on instinct. I shall, however, in this instance, content myself with exhibiting the erroneousness of his opinions respecting the Cuckoo, which will be best done by tracing the progress of an individual of that species from its extrusion from the egg till it arrives at maturity, or begins to propagate its kind; since an examination of its various means of acquiring information on those subjects which are of the greatest importance for it to know, will furnish the surest criterion of what is due to nature, and what to observation and tuition. Let us suppose, then, that a Cuckoo's egg is hatched in the nest of a Titlark about the middle of June. No sooner is the young bird disengaged from the shell than a disposition to eject whatever happens to be in the nest with it begins to manifest itself; and as young Cuckoos increase in size and strength very rapidly, it is soon enabled to turn out the nestling Larks, which are suffered to perish within a few inches of the nest, being entirely abandoned by their parents. Now, to what cause, I would ask, must we attribute this extraordinary propensity which shows itself so early? As Titlarks do not possess it, and as old Cuckoos, after they have deposited their eggs in suitable nests, interest themselves no further about their progeny, it is evident that it cannot be acquired from them; it

must, therefore, be perfectly innate. It may be remarked also, that the chirp of young Cuckoos is the same, as Dr. Jenner rightly observes, whatever the species of their foster-parents may be; hence it follows that it is not learned from any other bird, but is exclusively their own. After remaining in the nest about three weeks, this young bird deserts it early in July, and begins to acquire the use of its wings; but the care of the Titlarks is not entirely discontinued till towards the middle of August, when, having obtained a considerable command of wing, a desire to migrate prompts it to leave the country. The instinctiveness of this impulse one would be inclined to believe could not admit of a doubt; for Titlarks are not birds of passage, and as old Cuckoos depart late in June or early in July, it is clear that young ones cannot derive any benefit from their experience; yet Darwin maintains that migration among birds is as much an acquired art as navigation is among men.

With regard to the Cuckoo, I trust that I have said sufficient to convince every impartial inquirer that it is actuated in this particular purely by instinct; and, reasoning from analogy, I should be led to conclude that this is the case with all Migratory Birds without exception. But to return to the Cuckoo. Early in the ensuing spring it revisits the country where it was bred, or seeks another equally well suited to its habits and necessities. If a male bird, its well-known cry, which is now heard for the

first time, and which, I need scarcely observe, cannot have been taught to it, at once distinguishes its sex. If a female, it is solicitous, after impregnation, to secure a suitable asylum for its offspring ; and here, though Darwin denies it, the operations of instinct are most strikingly manifested. Without any previous instruction it discovers the nests of other birds, though it constructs none itself, by watching the birds build them; and selecting such only as from the size of the owners and their manner of feeding are best adapted to afford security to its eggs and proper nourishment for its young, it lays, just when the small birds themselves begin to lay, a single egg in each till it has produced its appropriate number, as if aware of the consequences which would ensue were two or more eggs deposited in the same nest.

Having, in this hasty sketch, shown that the instinctiveness of the most remarkable propensities of the Cuckoo admits of direct proof, it follows that the notion of the peculiarities of this extraordinary bird being acquired must be relinquished as quite untenable.

I may observe, in conclusion, that the history of the Cuckoo, by the evident marks of design which it displays in the admirable adaptation of means to ends, affords a convincing proof of the existence of a first principle of causation, the mysterious source of all that is good and beautiful in nature.

ADDITIONAL OBSERVATIONS ON THE CUCKOO.

In the 'Gentleman's Magazine' for April 1806, two instances are recorded of young Cuckoos having been occasionally fed by large numbers of birds of the same species as their foster-parents. It is stated that one of these nestlings was sometimes supplied with nourishment by upwards of twenty Titlarks, and that the other frequently received similar attentions from forty-eight Wagtails. From these facts the writer of the article concludes that birds which have the care of young Cuckoos are not always able to provide them with a sufficiency of food, and that on such occasions they procure the assistance of their neighbours of the same kind as themselves.

Colonel Montagu, in the Supplement to the 'Ornithological Dictionary,' calls in question the accuracy of these observations, and conjectures that the object of birds in thus assembling about nestling Cuckoos is not to administer to their necessities, but to assault and persecute them.

I have been favoured with a communication from Mr. Eaton, of York, which places the subject under consideration in a somewhat different light from that in which it has been viewed by any preceding ornithologist. Mr. Eaton informs me that in the summer of 1827 Captain Porter, who resides near the city of York, discovered a Hedge-Warbler's nest in his

garden containing a young Cuckoo only, the nestling Hedge-Warblers, all of which had been ejected by this formidable intruder, being found dead near the spot. The nest and its occupant were taken by the Captain and put into a cage, which was placed on the summit of a pole in the garden. In this situation the foster-parents speedily visited their captive charge, and, resuming their attentions, continued to feed it with great assiduity; but their most strenuous exertions failing to satisfy its increasing voracity, a third Hedge-Warbler was induced to cooperate with them in the arduous undertaking. As the young Cuckoo advanced in growth a still more ample provision of food became requisite, and a Spotted Flycatcher lent its assistance also in supplying the urgent demands of its appetite.

It may be here remarked that the purpose of these birds in visiting the young Cuckoo, from the numerous observations which were made upon them, and the favourableness of the situation and circumstances for ensuring accuracy, could not be mistaken.

I shall now proceed to notice the most novel and important fact detailed in Mr. Eaton's interesting narration—namely, the assistance afforded by the Spotted Flycatcher. "How," Mr. Eaton inquires, "could a pair of Hedge-Warblers prevail upon a bird of a different species to contribute to the support of their supposititious offspring?" Were the case as the question necessarily supposes it to have been, it

certainly would present a great difficulty; for the feathered tribes, though capable in some instances of connecting vocal sounds with the ideas intended to be signified by them, do not possess an artificial language: but I am inclined to think that the Hedge-Warblers did not intentionally exercise any influence whatever over their coadjutor.

Nestling Cuckoos, it is well known, are extremely clamorous when powerfully stimulated by hunger; indeed their cry for food is so incessantly repeated on such occasions, that it frequently leads to their discovery. Now this, I believe, is the exciting cause, which, by calling into operation the parental affections of birds so circumstanced as to be influenced by it, impels them to succour the young of strangers, even when they have not been placed under their immediate care; and the most probable reason which suggests itself why so many individuals of a kind are sometimes associated together in the performance of the same task, is that they are attracted by each other's calls.

The following anecdotes support these opinions.

A nestling Greenfinch was placed in the same cage with an adult Lesser Redpole, which brought it up with the utmost care.

Several young Sparrows, whose nest had been destroyed, were put into a small basket by a lady who pitied their helpless condition, and the basket was then conveyed to the grass plot in front of her house.

In this situation they soon became clamorous for food, and a great variety of birds hastened to the spot, many of which were observed to supply them with nourishment; but unfortunately they soon perished, probably from a deficiency of warmth, as they had not been hatched many days and were almost destitute of covering.

"The sons of Mr. Lord, of Ramsey, Essex, took four young Ravens from a nest and put them into a waggon in a cart-shed. About the same time they destroyed the young of a Magpie which had its nest near the cart-shed; and the old Magpies, hearing the young Ravens crying for food, carried them some, and constantly fed them till they were disposed of by the boys." (Trans. Linn. Soc. vol. xv. p. 10.)

I have thus attempted to show, contrary to the opinion of Montagu, that the author of the article in the 'Gentleman's Magazine' was perfectly correct in asserting that young Cuckoos are occasionally fed by a more than ordinary number of birds; but that it is erroneous to suppose that these numerous purveyors are invariably of the same species as the foster-parents of the Cuckoos, and that their proceedings are influenced entirely by the latter.

The belief that the Cuckoo sometimes constructs a nest and brings up its own young has been maintained by several intelligent naturalists, and was entertained by that excellent zoologist Dr. Fleming, as is evident from the following passage extracted

from the remarks on that bird given in his 'History of British Animals.' "In some cases, however," he observes, "it appears that the Cuckoo constructs its own nest. Thus, in a manuscript of Derham's on Instinct, communicated by Pennant to Barrington, it is stated that 'the Rev. Mr. Stafford was walking in Glossop Dale, in the Peak of Derbyshire, and saw a Cuckoo rise from its nest, which was on the stump of a tree that had been some time felled, so as much to resemble the colour of the bird. In this nest were two young Cuckoos, one of which he fastened to the ground by means of a peg and line, and very frequently for many days beheld the old Cuckoo feed these her young ones.'"

In my observations on the Cuckoo, page 69, I have pointed out several circumstances which completely invalidate Mr. Stafford's account, to which unfortunately so much importance has been attached; and it is gratifying to find that the conclusions there arrived at are supported by Dr. Jenner, whose opinion will command attention in the view he takes of the subject in his "Essay on the Migration of Birds" *.

Another supposed instance of a Cuckoo having incubated its eggs and nourished its young, which had escaped my former researches, is given in the octavo edition of 'Zoonomia' †, in an extract from a letter written by the Rev. Mr. Wilmot, of Morley, near

* 'Transactions of the Royal Society' for 1824.

† See the section on "Instinct," p. 246 *et seq.*

Derby; and as it is deserving of attention, I shall transcribe the entire passage. "In the beginning of July 1792," Mr. Wilmot writes, "I was attending some labourers on my farm, when one of them said to me, 'there is a bird's nest upon one of the coal-slack hills; the bird is now sitting, and is exactly like a Cuckoo. They say that Cuckoos never hatch their own eggs, otherwise I should have sworn it was one.' He took me to the spot, it was in an open fallow ground; the bird was upon the nest; I stood and observed her some time, and was perfectly satisfied it was a Cuckoo. I then put my hand towards her, and she almost let me touch her before she rose from the nest, which she appeared to quit with uneasiness, skimming over the ground in the manner that a hen Partridge does when disturbed from a new-hatched brood, and went only to a thicket about forty or fifty yards from the nest, and continued there as long as I stood to observe her, which was not many minutes. In the nest, which was barely a hole scratched out of the coal-slack in the manner of a Plover's nest, I observed three eggs, but did not touch them. As I had labourers constantly at work in that field, I went thither every day, and always looked to see if the bird was there, but did not disturb her for seven or eight days, when I was tempted to drive her from the nest, and found two young ones that appeared to have been hatched some days, but there was no appearance of the third egg.

I then mentioned this extraordinary circumstance (for such I thought it) to Mr. and Mrs. Holyoak, of Bidford Grange, Warwickshire, and to Miss M. Willes, who were on a visit at my house, and who all went to see it. Very lately I reminded Mr. Holyoak of it, who told me he had a perfect recollection of the whole, and that, considering it a curiosity, he walked to look at it several times, was perfectly satisfied as to its being a Cuckoo, and thought her more attentive to her young than any other bird he ever observed, having always found her brooding her young. In about a week after I first saw the young ones, one of them was missing; and I rather suspected my plough-boys having taken it, though it might possibly have been taken by a Hawk some time when the old one was seeking food. I never found her off her nest but once, and that was the last time I saw the remaining young one, when it was almost full-feathered. I then went from home for two or three days, and when I returned the young one was gone, which, I take for granted, had flown. Though during this time I frequently saw Cuckoos in the thicket I mention, I never observed any one that I supposed to be the cock bird paired with this hen."

This case, so circumstantially detailed and attested by witnesses of such high respectability, certainly has an imposing appearance; but a glance at the particulars intended to establish its accuracy is sufficient to convince every ornithologist who is familiar with

the economy of the Cuckoo, that the nest discovered by Mr. Wilmot's labourer did not belong to a bird of that species; indeed, from its situation and contents, there can scarcely be a doubt that it was a Goatsucker's. We are informed by Mr. Wilmot that in the beginning of July this nest contained three eggs, two of which were hatched several days after his attention was first directed to them, and that the parental duties of the mother towards her offspring were duly exercised till her last remaining nestling (one having been removed by some unknown cause) was nearly full-feathered, which could not have been less than eighteen or twenty days from its extrication from the egg. These, it will appear, are important facts; for, as old Cuckoos quit this kingdom early in July *, they plainly show that Mr. Wilmot's observations and those of his friends must have been made under the delusive influence of false impressions; and this opinion is confirmed by the peaceable manner in which the young birds occupied the nest while they continued together. Perhaps it may be imagined, by those to whom the arguments already advanced do not appear conclusive, that the maternal affection of the parent bird induced her to remain so much beyond the time at which adult Cuckoos usually retire: but this hypothesis will not remove a single difficulty; for Mr. Wilmot expressly states that during

* Old Cuckoos depart from the neighbourhood of Manchester on the 27th of June, at a mean of fifteen years' observations.

that period he frequently saw Cuckoos in an adjoining thicket, though he never observed any one which he supposed to be the mate of this female. Had Mr. Wilmot been a skilful ornithologist he would not have failed to examine the structure of the feet and bill of these nestlings, as he must have been well aware that by so doing he might have completely established the truth or fallacy of his supposition. It is almost unnecessary to insist upon the caution with which statements should be received from persons whose information does not qualify them to discuss the subjects upon which they write. The error into which Mr. Wilmot has fallen, being evidently occasioned by his imperfect acquaintance with the feathered tribes (for it is pretty clear that he did not distinguish Goatsuckers from Cuckoos, now that the economy of the latter species is better understood), will probably mislead none except those who are ignorant of natural history or greatly deficient in reflection; but that so distinguished a zoologist as Dr. Fleming should have contributed to extend and perpetuate the mistaken notion here controverted, by lending it the sanction of his authority, is to be regretted.

ON THE OCCASIONAL

DESERTION OF THEIR PROGENY BY BIRDS OF THE SWALLOW TRIBE.

The late celebrated Dr. Jenner, in a posthumous "Essay on the Migration of Birds," published in the first part of the 'Transactions of the Royal Society' for 1824, has briefly adverted to an extraordinary occurrence in the domestic economy of two species of British Hirundines, which, though far from uncommon, has either been altogether overlooked or totally disregarded by every preceding writer on ornithology whose works I have had an opportunity of consulting. The circumstance alluded to is the occasional desertion of their last-hatched broods by the Swallow and House-Martin. This singular fact, with which I was familiar previously to its enunciation by Dr. Jenner, my own researches confirm and illustrate; I shall therefore, without further prelude, proceed to state the results obtained from them.

The Swallow appears in the neighbourhood of Manchester on the 15th of April, and the House-Martin on the 25th of the same month, at a mean of

fifteen years' observations; but as these birds do not pair immediately on their arrival, and as they generally produce two and sometimes even three broods in a season, it frequently happens that individuals have nestlings in October, the period at which the great body of their species withdraw from this country *. Many of these young birds, from inability to accompany their congeners in their autumnal flight, are compelled to remain behind; and some of the most vigorous of them may occasionally be seen, in favourable situations, lingering about till the close of November, endeavouring to obtain a scanty subsistence. As the temperature of the atmosphere decreases, however, the insects they prey upon gradually diminish, till at last their utmost exertions to procure a sufficient supply of food are unavailing; they then speedily become enfeebled, and concealing themselves, as is usual in such emergencies, numbers undoubtedly perish from exhaustion. A few accidental discoveries of birds thus situated, before the vital principle has been quite extinct, may very possibly have given rise to the opinion that European Swallows pass the winter season in a state of torpidity.

It did not come to my knowledge that these late broods are sometimes deserted by the parent birds, before they are capable of providing for themselves, till the spring of 1821; when a pair of House-Mar-

* At Tarvin in Cheshire, in 1819, I saw a pair of House-Martins feeding their unfledged young on the 20th of October.

tins, after taking possession of a nest which had been constructed in the preceding summer, drew out the dried bodies of three nearly full-fledged nestlings which had perished in it, preparatory to appropriating it to their own purposes. About the same time, and near the same spot, a similar attempt was made by another pair of House-Martins; but all their efforts to dislodge the young proving ineffectual, they entirely closed up the aperture with clay, and so converted the nest into a sepulchre.

At first I was disposed to attribute the untimely fate of the nestlings thus unexpectedly discovered to the accidental destruction of one or both of their parents; but a little reflection induced me to change my opinion. So many instances were called to mind of the sudden departure of House-Martins, at periods when, to all appearance, they were most busily engaged in providing for their families, that what before was regarded as the unavoidable consequence of a fortuitous circumstance, I now began to suspect might be occasioned by a voluntary act of desertion.

In order to clear up this doubtful point, an examination of a considerable number of Swallows' and House-Martins' nests was immediately resolved upon; but, as the breeding-season had then commenced, it was deemed advisable, on more mature deliberation, to defer the undertaking until its termination: accordingly the search was postponed to the 27th of October, when, on being carried into

effect, several nests of both kinds were found to contain dead young ones. Satisfied that a fact of such frequent occurrence could not, with any degree of probability, be ascribed to accident, and convinced that the intentional desertion of their progeny by the parent birds afforded the only adequate explanation of it which was admissible, no further inquiry into the matter took place till November 1825. On the 19th of that month, an intelligent person, to whom I am indebted for numerous interesting communications relative to the natural productions of the neighbourhood in which he resides, assured me the suspicion I had formerly intimated to him, that House-Martins frequently leave their last-hatched broods to die of hunger in the nest, was perfectly well founded. Having narrowly watched the proceedings of those birds, many of which breed annually under the eaves of a large barn situated near his house in the chapelry of Blakeley, the result of his investigation, he informed me, was the complete confirmation of my supposition by the most unequivocal proof, namely that obtained directly from personal observation of the fact; and he did not doubt, he remarked, that dead nestlings might then be procured in abundance, if I would take the trouble to have the nests at the barn examined. This suggestion was acted upon without delay: repairing directly to the place, a ladder was quickly provided, and fourteen nests underwent a careful inspection; of these, five were found to con-

tain dead nestlings of various sizes*, and from another two eggs were taken, whose contents very evidently showed that they had been forsaken when on the point of being hatched. The nestlings collected on this occasion did not, it is true, exceed ten, which may be thought few when compared with the number of nests they occupied; but the second and third sets of eggs produced by those House-Martins which lay several times in a season, it should be recollected, only average three and two respectively; and even these may not all be prolific.

The Sand-Martin, I believe, has never been suspected of forsaking its progeny; yet, that it sometimes does abandon them, I have clearly ascertained by repeated inspections of the nests of that species during the winter months.

Whether the Swift, whose general habits are so dissimilar to those of the British Hirundines, ever deserts its young, I have not been able to determine, as it is rather a scarce bird in the neighbourhood of Manchester, and usually builds its nest in situations to which I have no access. That this may sometimes happen, however, in cases of extreme urgency, seems probable from an anecdote related by Mr. White in

* The extremely flattened appearance of some of these young birds, especially the smaller ones, which I was quite unable to account for, greatly excited my attention. I soon learned, however, that it was occasioned by the pressure of the Sparrows which every night took up their lodgings in the nests.

his 'Natural History of Selborne,' letter 52. "I have just met with a circumstance respecting Swifts," says that pleasing writer, "which furnishes an exception to the whole tenor of my observations, ever since I have bestowed any attention on that species of Hirundines. Our Swifts, in general, withdrew this year (1781) about the first day of August, all save one pair, which in two or three days was reduced to a single bird. The perseverance of this individual made me suspect that the strongest of motives, that of an attachment to her young, could alone occasion so late a stay. I watched, therefore, till the twenty-fourth of August, and then discovered that under the eaves of the church she attended upon two young, which were fledged, and now put out their white chins from a crevice. These remained till the twenty-seventh, looking more alert every day, and seeming to long to be on the wing. After this day they were missing at once; nor could I ever observe them with their dam coursing round the church in the act of learning to fly, as the first broods evidently do. On the thirty-first I caused the eaves to be searched, but we found only two callow dead Swifts, on which a second nest had been formed." Now, although the maternal affection of the female bird, in the instance before us, was sufficiently powerful to induce her to remain with her young till they were capable of accompanying her in a distant journey to a more genial climate, as is

sometimes the case with House-Martins when deserted by their mates, yet the conduct of the male, if it does not absolutely establish the fact that Swifts occasionally abandon their offspring to destruction, certainly affords strong presumptive evidence in its favour.

The frequent desertion of their last-hatched broods by the Swallow, House-Martin, and Sand-Martin, which is too well authenticated to admit of a doubt, must appear surprising to every one; but particularly so to those who are aware how highly the parental feelings of the feathered tribes are excited during the breeding-season. Few people are ignorant of the care and attention bestowed upon their offspring by our Domestic Fowls; and that the winged inhabitants of the fields and woods are, in their wild state, no less attached to their progeny than the reclaimed inmates of the poultry-yard, may be inferred from the following examples.

Early in August, 1825, a neighbour took a young Cuckoo out of a Titlark's nest, and, carrying it home with him, put it into a cage, which he hung in a pear-tree in his garden. The foster-parents, speedily discovering where their nursling was confined, notwithstanding the distance of the place from its former abode could not be less than three quarters of a mile, proceeded, with every demonstration of delight, to supply its immediate wants, and continued to provide it with food till it was unfortunately killed by a cat,

though there never was the least probability that it would be restored to liberty.

A still more extraordinary account is given by Montagu, in the Introduction to the 'Ornithological Dictionary,' p. 33 and following, of some Golden-crested Wrens, which were brought up in captivity by the parent birds. The narrator took the nest, he informs us, when the young were about six days old, and, putting it in a small basket, enticed the old ones by degrees to his study window. After allowing them sufficient time to become familiar with that situation, he placed the basket within the window, and then at the opposite side of the room. It is remarkable, he observes, that, although the female seemed regardless of danger, from her affection for her offspring, yet the male never once ventured into the room, though he constantly fed the young birds while they were at the outside of the window. The female, on the contrary, would feed them at the table at which he sat, and even when he held the nest in his hand, provided he remained motionless; but, on moving his head one day, while she was on the edge of the nest, she made a precipitate retreat, mistook the closed for the open part of the window, knocked herself against the glass, and fell breathless on the floor, where she lay for some time. However, recovering a little, she made her escape; and, in about an hour after, he was agreeably surprised by

her return, and she would afterwards frequently feed the young while he held the nest in his hand.

The Partridge has generally been represented by ornithologists as possessing a more than ordinary share of affection for its offspring; and the anecdote I am about to relate tends greatly to corroborate this idea. A near relation of my own * was told by the late Rev. W. Evans, of Mayfield, near Ashburn, that, some years since, his men, who were employed in cutting a field of mowing grass, brought to him a hen Partridge which they had caught on her nest. Being desirous to save the eggs from destruction, he ordered that they should be removed to his house, and placed on some hay in an unoccupied room, intending to put them under the care of a Domestic Hen; but wishing to know whether the parent bird would take any notice of them in that novel situation or not, he directed that she should be set down near them; when, to his great astonishment, she immediately ran to the spot where they were deposited, and, covering them with the utmost care, continued to sit till they were hatched. At first she was unremitting in her attention to her young, many of which were ultimately reared and set at liberty, but her anxiety to regain her freedom evidently increased with their growth; and, as soon as her assistance could be dispensed with, she was suffered to make her escape. This instance is the more remarkable as

* John Blackwall, Esq., of Blackwall, Derbyshire.

the Partridge has never been known to breed in captivity.

In a conversation which I had with Dr. Dalton in the summer of 1822, on the force of that impulse which leads birds to sit upon their eggs with so much patience and assiduity, he informed me that he had removed hen Redbreasts from their nests during the period of incubation, and that, upon gently replacing them, they had continued to sit as if they had not been disturbed. This experiment of Dr. Dalton's, which affords a striking instance of one of the most constant and powerful dictates of nature, self-preservation, being counteracted by a temporary excitation of superior energy, I have repeated with the Redbreast, Whinchat, Swallow, House-Martin, the Marsh, Cole, and Great Titmice, &c., not only when they have been sitting, but also when they have had small young ones, and almost always with success.

These examples, to which many more might easily be added, will be sufficient, I am persuaded, to convince every unprejudiced mind that the parental affections of the feathered tribes in general, and, what is more immediately to the purpose, of the Swallow and House-Martin in particular, are powerfully excited during the breeding-season. Now, what, we may ask, can induce the two last-named species and the Sand-Martin deliberately to consign their offspring to a painful and lingering death in

direct opposition to such intense feelings as these? The cause assigned by Dr. Jenner for conduct so anomalous is the desire to migrate; and this desire, he maintains, is produced by a change in the reproductive system; which, in the case of the birds under consideration, is supposed to take place prematurely. I say is supposed to take place; for I do not see how it is possible to ascertain what individuals will desert their progeny before they carry their intention into effect; and after the accomplishment of the act, no opportunity of examining the state of their internal organization can present itself: this notion, therefore, it is pretty obvious, must have originated in conjecture. That the sudden departure of the Swallow, House-Martin, and Sand-Martin, under circumstances so peculiar as those we have been contemplating, is occasioned by the desire to migrate, I do not dispute; but that this desire results from certain changes which occur periodically in the condition of the reproductive system seems to be quite inadmissible. Indeed the undeniable facts that every species of the feathered tribes, though subject to those changes, is not migratory, and that Snipes, Wild Ducks, &c., breed annually, and Woodcocks occasionally, in countries where the majority of those birds are known to sojourn during the winter only, are so totally subversive of Dr. Jenner's hypothesis, that to attempt a more complete refutation of it, in this place, would be superfluous.

It is particularly deserving of remark that the early death which invariably terminates the sufferings of those devoted nestlings that are abandoned by their parents, powerfully militates against the opinion that many of our Summer Birds of Passage, especially the Swallows, are capable of passing the winter season in a state of torpidity; for, if this belief in the liability of the European Hirundines to become torpid in autumn be well-founded, how does it happen that late-hatched broods of Swallows, House-Martins, and Sand-Martins, when deserted, uniformly perish, even under circumstances which are represented as rendering individuals of their species, too young or feeble to undergo the fatigues of migration, merely dormant? The advocates of torpidity will do well to consider this difficulty with attention; since, if not removed, it leaves them no alternative but to renounce as untenable the doctrine they maintain.

SINCE the foregoing observations were made on the occasional desertion of their last-hatched broods by several species of British Hirundines, a favourable opportunity of pursuing the investigation has again presented itself.

On the departure of the House-Martins, in October 1826, it was perceived that they left some broods to perish in the nests built under the eaves of a

barn, situated at the hill-top, in the chapelry of Blakeley, the edifice being that to which I have before alluded as a favourite haunt of those birds. This occurrence determined me to have the nests carefully examined; accordingly, after procuring the requisite assistance, a minute inspection of the whole, twenty-two in number, took place on the 11th of November; when, to my great surprise, thirteen were discovered to contain eggs and dead nestlings. With regard to the particulars, which are annexed, it is only necessary to remark that the nests are denoted by the progressive numbers, and that the state of the contents, as there described, is the same in which they were left by the parent birds.

Nests in which eggs were found.

Nests.		Contents.
No. 1	3	eggs, which had not been sat upon.
,, 2	1	egg, which had not been sat upon.
,, 3	5	eggs, which had been sat upon a short time.
,, 4	4	eggs, which had been sat upon a considerable time.
,, 5	3	eggs, on the point of being hatched.
Total	16	

Nests in which young birds were found.

Nests.	Contents.
No. 6......	2 nestlings newly disengaged from the egg.
„ 7......	3 nestlings a few days old.
„ 8......	2 nestlings about a week old.
„ 9......	2 nestlings nearly half grown.
„ 10......	2 nestlings about three parts grown.
„ 11......	2 nestlings nearly fledged.
„ 12......	5 nestlings nearly fledged.
„ 13......	1 nestling quite fledged.
Total..	19

From the unusual quantity of eggs and young deserted by the House-Martins on this occasion, it may be inferred that the desire to perpetuate their species was protracted, in a more than ordinary number of individuals, to the termination of their stay in this country, by the high temperature of the season*, and the great abundance of food consequent upon it.

The circumstance of fresh-laid eggs being in several instances forsaken, furnishes an additional argument to those previously urged against the hypothesis advanced by Dr. Jenner, that a premature change uniformly takes place in the physical condition of the reproductive system of those birds which abandon their progeny to destruction; for it is in the highest degree improbable that an organic change, sufficient

* On referring to my Meteorological Journal, I find that the mean temperature of the months of June, July, and August respectively was higher in 1826 than in many preceding years.

to induce a total alienation of parental affection—a change, let it be remembered, which, in every observed case, has been found to proceed gradually—should so suddenly succeed to the extremely active state of the system indicated by the recent production of prolific eggs. The simultaneous departure of both sexes also, when they desert their offspring, which, as far as my own researches extend, appears to occur with great regularity, is too remarkable a a fact to be accounted for on a principle so uncertain in its operation as that maintained by Dr. Jenner.

A belief represented by Dr. Fleming, in his 'Philosophy of Zoology,' vol. ii. pp. 72 & 73, as prevalent throughout Scotland, that Swallows are sometimes found torpid in their nests, has, most likely, originated in the discovery of the forsaken young of the Swallow and House-Martin (for both species are termed Swallows indiscriminately by the multitude) in a perishing condition or dead.

It appears from the following passage, extracted from Pennant's 'British Zoology,' vol. ii. page 155, that the Puffin, when placed under circumstances similar to those which induce birds of the Swallow tribe to desert their offspring, sometimes abandons its progeny. "The first young (of the Puffin) are hatched the beginning of July. The old ones show vast affection towards them, and seem totally insensible of danger in the breeding-season. If a parent is

taken at that time and suspended by the wings, it will, in a sort of despair, treat itself most cruelly, by biting any part it can reach, and when it is loosed, instead of escaping, will often resort to its unfledged young. This affection ceases at the stated time of migration, which is most punctually about the 11th of August, when they leave such young as cannot fly to the mercy of the Peregrine Falcon, who watches the mouths of the holes for the appearance of the little deserted Puffins, which, forced by hunger, are compelled to leave their burrows."

AN INQUIRY

INTO THE SUPPOSED

CAPABILITY OF THE PERIODICAL BIRDS TO BECOME TORPID.

Ornithologists, in their endeavours to account for the appearance and disappearance of the Periodical Birds, have usually laid much stress on the supposed capability of such birds to become torpid when exposed to the influence of those atmospherical agencies which are known to induce torpidity in hybernating animals. Now, whether birds are or are not endowed with the physiological property thus ascribed to them, is a subject of considerable interest; for if it can be shown that on being exposed to those external influences which occasion torpidity in animals prone to that state of lethargy they are not similarly affected (and such is the result obtained from the following experiments and observations), then the conclusion is obvious; the migration of the Periodical Birds must be regarded as an established fact.

Instances of young Cuckoos having been occasionally preserved alive through the winter are on record,

and to these I am enabled to add another by the kindness of Mrs. Warner of Crumpsall Green, near Manchester. This lady procured a nestling Cuckoo on the 12th of July, 1842, and by skilful management and constant attention succeeded in keeping it in excellent health till July 1843, when it died of inflammation caused by the negligence of the servant who had the care of it, Mrs. Warner being absent at the time on a visit to her sister who resided at a distance. In the second week of August the young bird began to exhibit symptoms of restlessness, which increased to such a degree that it was found requisite to keep it in darkness, lest the violent efforts it made to effect an escape from captivity should occasion its destruction. This extreme agitation, which continued with short intervals of repose through the day and night, began to subside towards the end of the month, and ceased altogether about the middle of September, having been limited to the night for a short period antecedent to the last date. The act of moulting, which commenced in February, proceeded with extreme slowness, and was never completed, though the bird was provided with nourishing food in abundance, and the temperature of the room in which it was kept was not suffered to fall below 50° Fahrenheit. Though this degree of temperature is much lower than that of the period at which young Cuckoos cease to appear in Britain, yet the subject of this

experiment never evinced the least disposition to become torpid, but, on the contrary, at that period (and only then) it was affected with extreme excitability and restlessness, indicative of a strong desire to change its locality.

A person named Thomas Holt brought to Crumsall Hall, on the 1st of July, 1826, a young Cuckoo which he had taken about an hour before out of the nest of a Titlark; and at my request he undertook to keep and treat it according to such instructions as from time to time I should communicate to him. This nestling, under the prescribed system of management, increased rapidly in growth and vigour; and as the principal object I had in view was to ascertain whether it would become torpid on the approach of winter or not, the cage occupied by it was placed in a room without a fire. In the ensuing November sharp frosts were of frequent occurrence; the maximum temperature of the last week in that month, indicated by a pair of Rutherford's horizontal self-registering thermometers, exposed to the open air in a shady situation, was 46°·5, the minimum 22°, and the mean 36°, as recorded in my meteorological journal: but in January, 1827, the cold became intense; the temperature descended to zero on the night of the 4th, and the mean for the month was so low as 34°·18.

Notwithstanding the extreme severity of the season, the young bird did not manifest the slightest symp-

tom of torpidity; and on the 12th of January I exhibited it at a meeting of the Literary and Philosophical Society of Manchester, at which time it was moulting, and in as good health, apparently, as birds usually are when undergoing that process, a minute to that effect being entered in the Journal of the Proceedings of the Society by my friend Mr. Peter Clare, who then officiated as secretary. On the 18th of the succeeding February this young Cuckoo died very suddenly; an event occasioned, in all probability, by exposure to severe cold; for a Six's self-registering thermometer, fixed in its cage several days before, indicated that the temperature had descended to 31°; and though the bird had previously resisted the effects of a much lower degree of temperature, yet it had not then made such progress in moulting, and was therefore better protected, being more completely covered with feathers. I may remark that in the year 1826 adult Cuckoos disappeared from the neighbourhood of Manchester in the first week of July, and that young birds of the same species were not observed there after the termination of August.

Admitting the difficulty of proving a negative, still I am inclined to think that the experiments detailed above, when taken in conjunction with others yet to be adduced, go far to establish the opinion that birds have not any physiological tendency to torpidity.

In advocating this view of the subject, I am aware that I stand opposed to the high authority of Cuvier, who, in treating upon the Sand-Martin (*Hirundo riparia*) in the first edition of the 'Règne Animal,' tome i. p. 374, asserts, with reference to its supposed torpor, that "il paraît constant qu'elle s'engourdit pendant l'hiver, et même qu'elle passe cet état au fond de l'eau des marais;" and the same opinion is reiterated by Humboldt in one of his published works; but as I have not an opportunity of referring to them at present, I cannot state in which. Both these celebrated authors, however, have omitted to communicate the particulars which led them to this conclusion; and the bare assertion even of persons the most distinguished in the annals of science cannot be received as equivalent to direct evidence.

It has been stated that the Cuckoo, Swallow, House-Martin, and some other species of Periodical Summer Birds moult in the interval which elapses between the times of their disappearance and reappearance in this country (see p. 15 *et seq.*). How utterly irreconcilable this plain fact is with the hypothesis of their passing that interval in a state of torpidity needs scarcely to be insisted upon; indeed it is absolutely inconceivable that birds in a lethargy so profound as that in which the animal functions seem to be suspended should undergo a change of plumage, when Mrs. Warner's Cuckoo, enjoying all

the advantages of vital energy, high temperature, and stimulating nutriment, failed to do so.

I shall now proceed with the experiments. Three young House-Martins were taken from a nest in the chapelry of Blakeley, near Manchester, in September, 1827, and were kept in a room without fire. From the 21st of the November following to the 27th inclusive there was a continuance of inclement weather, the maximum temperature for the period being 47°·5, the minimum 19°, and the mean 33°·39; yet not the least disposition to become torpid was apparent in the young Martins, though they did not long survive the test to which they had been subjected: indeed, for Periodical Birds to suffer severely, and even to perish from cold and hunger during their sojourn in this country, is no uncommon case; but a lowering temperature and a decreasing supply of food, when they pass certain limits, are the very conditions which should induce torpidity in them were they liable to be so affected, and which actually do produce such a result in animals known to be endowed with this constitutional peculiarity.

I myself have repeatedly seen large numbers of Swallows reduced to the necessity of alighting in fields for the purpose of obtaining some of the insects which a low temperature had constrained to seek refuge among the herbage; and so greatly were they

enfeebled, as almost to suffer themselves to be taken with the hand.

Severe and long-continued frosts, especially when accompanied with snow, often prove very fatal to the Redwing (*Turdus iliacus*); and under such circumstances, I have occasionally found individuals of this species dead or in a dying state.

Numerous instances of a similar kind might be selected from works on natural history; but two will suffice. I quote from "A Catalogue of the Norfolk and Suffolk Birds, with Remarks," by the Rev. R. Sheppard and the Rev. W. Whitear, published in the 'Transactions of the Linnean Society,' vol. xv. "The following extraordinary circumstance in the natural history of the Swallow, which occurred at Christ Church, Ipswich (the residence of the Rev. Mr. Fonnereau), very forcibly illustrates the unusual coldness and backwardness of the season. 'On the mornings of the 5th and 6th of June, 1816, the gardeners could have taken up hundreds of these birds in their hands; they were collected in knots, and sat on the grass in parcels of thirty and forty. This, there is reason to believe, was owing both to cold and hunger' ('Suffolk Chronicle,' June 15th, 1816). The same summer many House-Martins were found dead on the ground in Norfolk, and others were so weak that the cats sprang upon them and caught them as they flew near the ground. A pair of these birds, which had completed a nest

under the eaves of our house, were both found dead in it before any eggs were laid. From the above circumstances, birds of this kind were unusually scarce throughout the summer."

In the 'Report of the Twenty-fifth Meeting of the British Association for the Advancement of Science, held at Glasgow in 1855,' Trans. of the Sections, pp. 112 & 113, some highly interesting facts are recorded relative to the great mortality among birds of the Swallow tribe caused by the unusually low temperature of the 30th and 31st of May in that year, the maximum for the period being 50°, the minimum 35°, and the mean 41°·2, as indicated by a thermometer in the shade.

The author of the communication, Mr. E. J. Lowe, states that "on the 30th of May the Swallows became so tame that they flew about the legs of persons, and could be caught without difficulty; and on the following morning most of them lay dead upon the ground or in their own nests.

"In this neighbourhood (near Nottingham) the greatest mortality was occasioned amongst the House-Swallow (*Hirundo rustica*), yet solely because this bird predominates.

"Near the Red-Hill Tunnel at Thrumpton there are great numbers of Sand-Martins (*Hirundo riparia*), and there, in a saw-pit on the banks of the river Soar, hundreds congregated and died.

"At Borrowash, near the Derwent river, there are

very many White Martins (*Hirundo urbica*); they also congregated and died, lying ten and twelve deep on the different window-sills.

"The manner in which they congregated was a curious feature in the occurrence. A Swallow would fly round a heap of dead and dying companions, and then suddenly dart down and bury itself among them."

How the well-known fact that the Periodical Summer Birds which appear in this country in spring uniformly bear only a small proportion to those that withdraw from observation in autumn is to be satisfactorily explained on the supposition that the birds in question pass the cold season in a state of torpidity, the ingenuity of those persons who advocate the hypothesis of hybernation must determine.

The effects produced by variations in temperature upon the Dormouse (*Myoxus avellanarius*) and other animals whose liability to become torpid is unquestionable, claim attention in the next place.

Having obtained five healthy Dormice, I endeavoured, at various periods in the year 1824, to render them torpid by the employment of artificial means. Two of them were placed in a tall cylindrical glass jar, with a supply of flax and cotton for the construction of a dormitory; and when they were familiar with their new residence,

it was weighted to keep it steady, and put into a tub containing cold water, which rose within a few inches of its top. The temperature of the water was further reduced by causing to be speedily dissolved in it finely pulverized muriate of ammonia and nitrate of potash mixed in equal quantities, the degree of cold produced in the glass jar being ascertained by means of a small thermometer included within it. Experiments of this kind were soon perceived to be too uncertain in their results to effect the purpose for which they were instituted; for though the Dormice sometimes became perfectly lethargic, yet it frequently happened that no such consequence followed, the rapid fluctuations in the temperature of the water, and the motion unavoidably attendant upon the process, combining to stimulate the animals and prevent torpidity.

Disappointed in this attempt, I resolved to rely on the natural temperature of the atmosphere solely; and on suspending a cage containing two of the Dormice in the open air, from a window having a north aspect, whenever the thermometer was unusually low for the season, I had the satisfaction to find that by this simple expedient they were rendered completely torpid at intervals in every month of the year 1824, the other three Dormice continuing quite alert on those occasions if subjected to the influence of a high degree of temperature. After constructing a comfortable bed of flax and

cotton, on being exposed to a cold atmosphere, the two Dormice in the cage invariably placed themselves in their usual posture of repose, when sleep ensued, which gradually lapsed into torpidity, accompanied with all the customary symptoms, such as decreasing circulation, respiration, temperature, and irritability. While in a state of transition, the respiration became intermittent, and, with the circulation, ultimately ceased to be apparent. The temperature of the skin slowly descended to that of the atmosphere or nearly so, and the nervous irritability diminished so greatly that loud and sudden sounds, whether grave or acute, produced no sensible effect; punctures also with sharp instruments, and slight electric shocks and sparks given by means of a Leyden-jar and an electrophorus, merely occasioned a degree of muscular contraction so small as scarcely to be discerned; but the repeated application of external stimuli causing bodily pain, exposure to a current of hot or cold air, or to a high degree of temperature alone, at all times prevented the animals from becoming torpid, and when torpid speedily revived them.

The Hedgehog (*Erinaceus europæus*), Long-eared Bat (*Plecotus auritus*), Wasp (*Vespa vulgaris*), Flesh-fly (*Musca vomitoria*), Housefly (*Musca domestica*), Peacock Butterfly (*Vanessa io*), and Tortoise-shell Butterfly (*Vanessa urticæ*), when found in winter in a torpid state, I have frequently restored to animation

by subjecting them to a high temperature, perfect torpidity having been again induced on submitting them to the requisite degree of cold.

In the year 1829 I captured several specimens of the large aquatic Beetle *Dyticus marginalis*, for the purpose of making some observations and experiments relative to the structure and use of the cup-shaped suckers with which the males have the tarsi of the first and second pairs of legs provided on the underside; and putting them into an earthenware vessel containing water, I supplied them during several weeks with raw flesh, which they devoured greedily. The month of December in the same year terminated in severe frost; the maximum temperature of the last week was 37°, the minimum 16°·5, and the mean 28°·75; consequently the water in the earthenware vessel was frozen into a solid mass of ice, and it remained in that state for some days; yet, on being gradually thawed, the Beetles resumed, and long continued to exercise, their customary functions.

From the foregoing experiments and observations, it appears that birds are not liable to be rendered torpid on being exposed to the same external agency which quickly induces torpor in various animals known to possess a constitutional proneness to that state of lethargy. It is obvious, therefore, that they must differ physiologically from those animals;

and I am disposed to think that the legitimate inference to be deduced from the facts is, as I have already stated, that birds have no tendency whatever to torpidity, which seems to result from diminished nervous irritability, occasioned by a low degree of temperature, more or less directly affecting numerous important vital functions, as circulation, respiration (and necessarily the evolution of animal heat), digestion, secretion, assimilation, absorption, and excretion.

That the Periodical Birds which visit this country in autumn are not rendered torpid by cold, will be readily acknowledged, as they are known to quit the north of Europe on the approach of winter for more genial climates in lower latitudes; and it has been shown that even in Britain the Redwing frequently falls a victim to severe and protracted frosts. Why, then, should any reluctance be felt to admit that the Periodical Birds, whose appearance in spring is attended with so many pleasing associations, retire from this kingdom on the return of the cold season to more southern countries, where a suitable temperature and an ample supply of food are to be found? I have endeavoured to prove by experiment that they do not become torpid; and I may add that a premium of five pounds a head, publicly offered for birds in a state of perfect torpidity, when I resided at Crumpsall Hall, failed to produce a single individual, though, for a fifth part of the sum, I know that

I might have been abundantly supplied with torpid Bats and Hedgehogs.

Thus it is seen that experiment, observation, and analogy are all in favour of the conclusion at which I have arrived—namely, that there is no physiological tendency whatever in birds to become torpid.

ON

THE INSTINCTS OF BIRDS.

THE manners and economy of the inferior orders of animals form one of the most interesting subjects of investigation which can engage the attention of the philosophic naturalist. An acquaintance with this important but greatly neglected branch of zoology conduces to the correction of numerous erroneous opinions and groundless prejudices, and opens an inexhaustible source of valuable information and rational amusement. It throws much light also on the operations of that mysterious agency which regulates those actions of animated beings that, although attended with consciousness, do not result from observation, instruction, experience, or reflection, and have therefore generally been termed *instinctive actions*.

When we consider how many creatures are objects of superstitious dread or veneration, and what multitudes, even in this enlightened age and country, are sacrificed annually to mistaken notions of their mischievous properties, reason and humanity are alike

shocked; and we deeply deplore the prevalence of errors which the zealous promulgation of more correct ideas and liberal sentiments can alone effectually remedy.

That useful bird the White Owl, which, on account of the great number of mice it destroys, ought to be carefully protected by the farmer, is frequently looked upon with terror as a forerunner of death, which it is supposed to announce by its loud dissonant screams; and a small Coleopterous insect, the *Anobium tessellatum* of entomologists, has obtained the appellation of death-watch, from a fancied connexion between the ticking sound it produces and that awful event. The Raven and Magpie are imagined, by persons of weak intellects and timid dispositions, to prognosticate evil; and this notion has been extended and perpetuated by the allusions made to it in numerous legendary tales, and in the writings of our poets. To take the life of the Swallow or House-Martin, or to disturb their nests, is regarded as an unlucky event, portending disaster to the unfeeling aggressor; and the Redbreast and Wren owe much of their security to popular prepossessions equally without any rational foundation. Many birds which subsist almost entirely on insects (as the Cuckoo, Redstart, and Spotted Flycatcher) are shot by ignorant gardeners and nurserymen, indiscriminately with those species which feed principally on the seeds of plants and other vegetable produc-

tions. The Goatsucker and the Hedgehog are falsely accused of sucking the teats of animals; and those beautiful and harmless reptiles the Common Snake and Blindworm are destroyed without pity, upon the groundless supposition that they are venomous.

These are a few instances only, selected from many that have fallen under my own observation, of the pernicious consequences which result from an ignorance of that useful portion of natural history which at present engages our consideration.

We will now proceed to notice briefly some of the numerous advantages to be derived from a successful cultivation of that delightful study; and a correction of the above-mentioned errors and abuses, with the needless waste of life which it would prevent, is not among the least of them. For the preservation of our persons and property from those creatures by which they are liable to be injured, for the best methods of promoting the increase, improving the condition, and effecting the subjection of such as contribute to our benefit or amusement, and for the skilful management of our valuable reclaimed and domestic animals, which supply us with so many comforts and luxuries, we must depend, in a great measure, upon our knowledge of their habits, manners, and propensities. To this knowledge, also, the practical physiologist is indebted for the means of enlarging his acquaintance with the phenomena of life; the scientific naturalist, and particularly the

ornithologist, for an excellent mode of distinguishing species, under circumstances in which the ordinary rules for determining them are of little or no avail; and the physico-theologist for a more comprehensive view of the power, wisdom, and goodness of the Creator as manifested in his living works.

Having thus succinctly adverted to the great importance of accurate information in this extensive department of zoology, I shall now limit my remarks exclusively to the feathered tribes; and whoever attentively considers the diversified operations of the various active powers with which the interesting beings that compose that pleasing division of the animal kingdom are endowed, cannot fail to receive a high degree of mental gratification.

It frequently happens that the experienced observer is enabled to discriminate birds with the utmost certainty by their notes, manner of flight, or some other peculiarity, when he has no opportunity of procuring specimens of them, or of ascertaining the colours of their plumage. Indeed, in this last particular, distinct species, as the Yellow Wren and Lesser Pettychaps, several of the Larks, Finches, &c., so nearly resemble each other, and individuals of the same species, as many of the Falcons, Gulls, Sandpipers, Ducks, &c., are so very dissimilar, and vary so greatly with age, change of season, and other circumstances, that colour cannot always be relied upon as affording sufficient evidence of specific identity. A

much surer criterion will be found in the uniformity so conspicuous in the manners and economy of birds of the same kind—a coincidence which can only be accounted for by supposing that their actions are instinctive. That this is actually the case I shall attempt to show, though it must be admitted that they are occasionally modified, in a considerable degree, by the exercise of the intellectual faculties.

I will not occupy the time of the reader in examining the many vague and contradictory opinions which have been entertained with regard to the nature of instinct by the various authors who have written on the subject, being convinced that they are purely speculative, and tend to retard rather than advance the progress of science. We must not, however, pass unnoticed the sophistical doctrine, so ingeniously maintained by Dr. Darwin, in 'Zoonomia' *, that what is usually termed instinct in animals has reference to the powers of intellect solely; since the feathered tribes, notwithstanding the highly curious and unequivocal examples of instinctive actions which they exhibit, have furnished him with some of his most plausible arguments in support of it.

Depending on the assertion of Kircher†, that young Nightingales, when hatched by other birds, never sing till they are instructed, and confiding in the remark

* See the Section on Instinct, vol. i.

† 'De Musurgia,' Cap. de Lusciniis.

of Jonston* that the Nightingales which visit Scotland have not the same harmony as those of Italy, Dr. Darwin was hastily led to conclude that the songs of birds in general are artificial. Having observed also that poultry readily obey their usual summons to be fed, and that young Ducks hatched under the Domestic Hen soon appear to understand her calls, and giving credit to the mistaken idea that Wagtails and Hedge-Warblers feed the young Cuckoos they bring up long after they leave the nest whenever they hear their cuckooing (which, on the authority of Linnæus †, he states to be their cry of hunger), he was induced to adopt the same opinion respecting their calls. Now, whether the song of the Nightingale results from education, as Kircher maintains, or whether it is wholly independent of tuition, I have never had any direct means of deciding, as the bird is only an accidental visitor in this part of the kingdom. From unexceptionable experiments, however, made with the greatest care on several other species of British Singing Birds, I have no hesitation in affirming that the peculiar song of each is the natural consequence of an instinctive impulse, combined with a suitable state of the vocal organs. This latter condition deserves particular attention; for it is a fact, which has been very generally overlooked, that most of our songsters are absolutely unable to continue their melodious strains

* Pennant's 'British Zoology.'

† 'Systema Naturæ.'

beyond the latter end of July or the beginning of August, the strenuous but unavailing exertions they make to prolong them sufficiently proving their silence not to be a matter of choice, but of necessity. This circumstance, together with the extreme difficulty they experience in recommencing their songs in spring, clearly demonstrates that their delightful warblings depend upon the energy of those muscles which contribute to form the voice—an energy which appears to be influenced chiefly by food, temperature, health, and the exercise of the reproductive functions; for by due attention to the regulation of these particulars the vocal powers of caged birds may be called into action or circumscribed at pleasure. Of this fact, persons who have the management of breeding Canaries may easily satisfy themselves; and female birds in a state of captivity, when brought into high condition, are known occasionally to assume a song somewhat resembling that of the male. That Jonston must have been deceived in supposing he heard the Nightingale in Scotland is evident, as that Warbler, it is well known, is never found north of the Tweed in Great Britain. It has been ascertained, too, contrary to the opinion of Linnæus, that young Cuckoos, before they come to maturity, utter a feeble cry only; they cannot, therefore, acquire the calls of their species while they remain in this country. No wonder, then, that the conclusion Dr. Darwin arrived at was erroneous, when the premises on which his reasoning is grounded are so inaccurate.

It is not, let me remark, intended to insinuate that birds are incapable of attaining any knowledge of each other's notes, since our Domestic Fowls, in many instances, are certainly enabled, by observation and experience, to connect vocal sounds with the ideas they are designed to convey *. The House-Martin, also, readily learns to distinguish the Swallow's call of alarm; and the Ringed Plover, Sanderling, and Dunlin, when associated together, evince, by the promptitude and exactness with which they perform their various aërial evolutions, that they comprehend one general signal. All that is meant to be insisted upon is, that the notes peculiar to every species, in a state of nature, are instinctive. This I have endeavoured to prove, in an essay on the Notes of Birds (*suprà*, p. 26), by showing that even such individuals as are brought up in situations where they have no opportunity of being instructed in their appropriate notes, do nevertheless utter them naturally.

The pairing of wild birds, and the period at which they prepare to perpetuate their species, are determined, according to Dr. Darwin, by the acquired knowledge that their joint labour is necessary to procure sustenance for a numerous progeny, and that

* When our Domestic Cock gives notice to his mates that he has discovered some choice morsel of food, the Turkey-hens always hasten to secure the delicacy, which the gallant Chanticleer suffers them to take, even out of his beak, without the least molestation.

the mild temperature of the atmosphere in spring is suitable for hatching their eggs, and for producing a plentiful supply of that nourishment which is wanted for their young. This opinion he attempts to support by the fact that poultry, which have an abundance of food throughout the year, and are protected from the inclemency of the weather, lay their eggs at any season and never pair. But it should be recollected that this is not the case with Pigeons placed under similar circumstances, which do pair, though they produce only two young ones at a time; and that the Pheasant among our naturalized, and the Black Grouse among our native birds, though they have both large families to provide for, are, in their wild state, polygamous. Indeed it is evident from the anatomical and physiological researches of Mr. John Hunter and Dr. Jenner that the sexual connexions of birds, and the season at which they breed, depend upon certain conditions of their organization, and not upon any information derived from experience or instruction.

The propensity to propagate their species in this class of animals is well known to be of periodical occurrence, and dissection clearly proves that it is always accompanied by a very perceptible alteration in the reproductive system. Besides, reclaimed birds, under the influence of a plentiful supply of nourishing food, shelter from the inclemency of the weather, and the various stimuli with which domestication is usually attended, may be kept in this state of sexual excita-

tion for several years with comparatively little interruption. A check to the greatly increased activity of the reproductive powers so induced is speedily given, however, by a diminution of sustenance and exposure to cold; at the same time, also, a visible change takes place in the physical condition of the organs of reproduction.

In the selection of their mates, the feathered tribes are undoubtedly governed by instinct, as there is reason to believe that different species, in a state of nature, rarely pair together, however near their affinity or general resemblance may be. The Rook is not observed to breed with the Crow, the Titlark with the Lesser Field-Lark or Rock-Lark, the Sedge-Warbler with the Reed-Wren, or the Cole Titmouse with the Marsh-Titmouse. Now, were every individual left to the unrestrained exercise of its own discretion in a matter of such essential importance, the utmost confusion might be expected to ensue; an unprolific, hybrid progeny would be speedily produced, and the total extinction of many species might be the ultimate consequence. But the allwise Author of nature has not suffered the reproduction of his creatures to be liable to such a contingency, but has implanted in the mind of each a powerful predisposition to form sexual unions with its own kind exclusively. Thus the evils which would unavoidably result from the indiscriminate intercourse of various species are effectually prevented.

It must be admitted that an intermixture of distinct species does sometimes occur among our domesticated birds; but this deviation from their ordinary instinct is rare, and may with great probability be ascribed to a change in their organization, occasioned by the artificial mode of life to which they have been subjected. Now, as it is a maxim in physiology that the exercise of every animal function is dependent upon its appropriate material organ, any display of new instinctive phenomena, in birds which have long been under the control of man, may also be attributed to the operation of the same physical cause. The singular propensity of the Cropper-Pigeon to inflate its craw with air, and the still more remarkable disposition of the Tumbler to turn itself over backwards when on wing, which are permanent characters in those varieties of the Rock-Dove, being transmitted by generation, can be satisfactorily accounted for on the foregoing supposition only. How unsafe it must always be to draw general conclusions from the habits and propensities of Domestic Fowls alone, whose instincts frequently undergo changes as marked as those of their plumage, by the unnatural state in which they are kept, needs scarcely to be insisted on.

Dr. Darwin conjectures that birds learn how to build their nests from observing those in which they are educated, and from their knowledge of such things as are most agreeable to their touch in respect to

warmth, cleanliness, and stability; but the undeniable fact that birds, when taken very young, even before they can see, and brought up in confinement, do sometimes construct nests, is alone sufficient to refute this opinion.

The Sparrow-Hawk and Kestril often make use of the deserted habitation of the Magpie as a receptacle for their eggs, and the Sparrow frequently takes forcible possession of the rustic dwelling of the House-Martin for the same purpose. Why, then, are they never known to build nests similar to those which they thus appropriate to themselves? and why does not the Cuckoo, which is always brought up in the nest of some other bird, construct one itself? * The reason is obvious: the act of nidification is not regulated by observation or instruction, but is under the immediate direction of instinct.

Guided by that mysterious power, individuals of the same species, under like circumstances, always adhere to the same style of architecture. Thus some of the smaller birds, which produce a large number of eggs, constantly make the entrance to their nests very narrow, and line the interior with an abundance of such materials as conduct heat slowly; while the Ring-Dove, which lays two eggs only, forms so slight a structure that they may frequently be seen through

* I have pointed out the errors into which Dr. Darwin has fallen in his remarks on the Cuckoo in my observations on that bird, p. 72.

it. The Partridge, Land-Rail, and those birds whose young are able to run almost as soon as they are hatched, generally give themselves very little trouble in providing nests for their progeny; and some species of Waterfowl do not make any, but deposit their eggs in the crevices and on the projecting shelves and ledges of lofty rocks, or upon the bare ground. The Sociable Grosbeak builds in society under a common roof. The Pensile, Abyssinian, and Philippine Grosbeaks construct curious nests, which they suspend from the slender twigs of trees, particularly such as grow over water, by these means securing their offspring from the predatory attacks of their numerous enemies; and the Tailor-bird frames its temporary abode by sewing leaves together with the flexible fibres of plants, and lining the cavity with the lightest and softest animal or vegetable down.

It is true that, in preparing their nests, birds occasionally accommodate themselves to some circumstances, and take advantage of others, in a manner which seems to indicate a large share of intelligence. The Wren, for example, usually adapts the exterior of its compact fabric to the situation in which it is placed. When built against a haystack, hay is almost invariably made use of; and green mosses or withered leaves and fern are employed, as green or the various shades of brown prevail in its vicinity. Nor let it be imagined that these substances, which from their contiguity are often most easily procured, are selected

merely as a matter of convenience; for I have known this minute bird bring long pieces of straw from a considerable distance with much toil, and, with incredible perseverance, mould the stubborn material to its purpose, solely because its colour approached that of a garden-wall, a hole in which, occasioned by the giving way of a loose brick, it had chosen to place its nest in.

A lady, who kept Canaries, was obliged to separate a young brood from their parents, having observed that the male bird stripped off the soft feathers from their necks and wings for the purpose of lining a newly constructed nest with them, notwithstanding a supply of old feathers had been put into the cage. From this remarkable fact, for which I am indebted to Dr. W. Henry, it is evident that Canaries do not collect materials for their nests indiscriminately, but that they make a selection, in which they are directed by powers of a higher order than those of a merely instinctive character.

Mr. White, in his 'Natural History of Selborne,' page 59, informs us that in Sussex, where there are very few towers and steeples, the Jackdaw builds annually under ground in deserted rabbit-burrows. The same author remarks also (pp. 175, 176) that many Sand-Martins nestle and breed in the scaffold-holes of the back wall of William of Wykeham's stables, which stands in a very sequestered enclosure, facing a large and beautiful lake, near the town of

Bishop's Waltham, in Hampshire; and some birds, as already represented, frequently spare their own labour by taking possession of the nests of others.

In these instances there certainly appears to be a great display of sagacity; yet there are facts which seem to render it doubtful whether the feathered tribes are capable of deriving much benefit from experience, or of exercising any remarkable degree of intelligence. Thus birds when engaged in the performance of their parental duties expose themselves, without hesitation, to dangers which at another period they would carefully avoid. Many species also, while under the incitement of appetite, are readily snared by the most simple contrivances, directly after witnessing the capture of their companions; and Rooks continue to breed in those rookeries where the greater part of their young are destroyed every spring*. For three successive seasons a pair of Redstarts persisted in making their nest in the upper part of our pump, on that end of the lever which is connected with the rod of the piston, and, of course, always had it disturbed when that engine was used. Mr. White observes†, too, that in the neighbourhood of Selborne House-Martins build, year by year, in the corners of the windows of a house without eaves,

* I was assured by the late T. Legh, Esq., that many thousands of young Rooks were shot every breeding-season in his extensive rookery at Lime Park, in Cheshire.

† 'Natural History of Selborne,' p. 160.

situated in an exposed district; and as the corners of those windows are too shallow to protect the nests from injury, they are washed down every hard rain; yet the birds drudge on to no purpose, from summer to summer, without changing their aspect or house.

These actions, it cannot be denied, seem to indicate a more limited degree of sagacity in birds than might be inferred from those previously spoken of. This apparent contradiction, however, may be easily reconciled by admitting what, in all probability, will be thought sufficiently obvious, that the dictates of the understanding are frequently too feeble to resist the powerful influence of instinctive impulse. Several examples illustrative of this view of the subject will be found interspersed through the remainder of the essay; there is not any necessity, therefore, for entering into a more detailed consideration of it here.

After the business of nidification is completed, parturition commences, which is succeeded by incubation; and as birds will frequently continue to deposit their eggs in the same nest, though all, except one or two, should be removed as fast as they are laid, or exchanged for others of a different size and colour, and as they will sometimes, after having produced their appointed number, sit upon a single egg, on the eggs of other birds introduced for the purpose of experiment, on artificial ones of chalk, or even upon stones of any irregular figure, it is plain

that the acts of depositing and incubating their eggs can be ascribed to instinct only. The parental offices of birds to their young are also regulated by instinctive feeling, as is evinced by their bestowing the same attention on the offspring of other species, when committed to their care, as they do upon their own. Thus the Titlark and Hedge-Warbler manifest the warmest attachment to the young Cuckoos, their foster-nurslings, though they suffer their own progeny, ejected by the intruders, to perish from neglect within a short distance of the nest; and this affection continues, with little diminution, till their supposititious offspring have nearly attained their full growth: yet under other circumstances they would pursue and persecute them with the utmost rancour.

The instinctive nature of these actions is likewise satisfactorily established by the fact that birds, when taken very young and brought up in confinement, not only construct nests occasionally, but also lay their eggs in them, which they will sit upon till hatched, should they prove prolific, and will then carefully attend to the young. An anecdote or two, serving more fully to corroborate the opinion advanced above, will not, it is hoped, be unacceptable.

In the beginning of May 1812, having found a Buzzard's nest containing a single egg, the egg was taken and a light-coloured stone substituted for it, over which a rat-trap was set. The Buzzard sat upon the trap a day and night, when it was discovered

that the iron ring which confined the spring had not been withdrawn. The ring was then removed, and on visiting the nest afterwards the female was found caught by the feet. This change of character, in so watchful and quick-sighted a bird as the Buzzard, is certainly very surprising, and must baffle every attempt to connect it with any intellectual process.

A highly interesting anecdote, illustrative of the attachment of the Raven to its eggs, is thus admirably related by Mr. White* :—"In the centre of a grove there stood an oak, which, though shapely and tall on the whole, bulged out into a large excrescence about the middle of the stem. On this a pair of Ravens had fixed their residence for such a series of years that the oak was distinguished by the title of the Raven tree. Many were the attempts of the neighbouring youths to get at this eyry: the difficulty whetted their inclinations, and each was ambitious of surmounting the arduous task. But when they arrived at the swelling it jutted out so in their way, and was so far beyond their grasp, that the most daring lads were awed, and acknowledged the undertaking to be too hazardous. So the Ravens built on, nest upon nest, in perfect security, till the fatal day arrived on which the tree was to be levelled. It was in the month of February, when those birds usually sit. The saw was applied to the but, the wedges were inserted into the opening, the woods echoed to

* 'Natural History of Selborne,' p. 6.

the heavy blows of the beetle or mallet, the tree nodded to its fall; but still the dam sat on. At last, when it gave way, the bird was flung from her nest, and, though her parental affection deserved a better fate, was whipped down by the twigs, which brought her dead to the ground."

That ardent affection which most birds feel for their young seems to awaken their dormant energies, and to inspire them with a degree of courage and address that is called forth on no other occasion. Nor is the violence of this affection, to use the language of Mr. White, more wonderful than the shortness of its duration. Thus every hen is, in her turn, the virago of the yard in proportion to the helplessness of her brood, and will fly in the face of a dog or a sow in defence of those chickens which in a few weeks she will drive before her with relentless cruelty. The Partridge will tumble along before a sportsman in order to draw away the dogs from her helpless covey; and a very exact observer (the Rev. John White) has remarked, that a pair of Ravens nesting in the rock of Gibraltar would suffer no Vulture or Eagle to rest near their station, but would drive them from the hill with amazing fury; and that even the Blue Thrush, at the season of breeding, would dart out from the clefts of the rocks to chase away the Kestrel or the Sparrow-Hawk. Indeed, so regardless of danger are some species while their nestlings are small, that I have known the Redbreast,

Whinchat, Great Titmouse, &c., when introduced to their nests after having been forcibly removed to a distance from their unfledged young, remain quietly upon them as if they had not been molested. Yet, although this instinct, the transient effects of which depend most likely on a temporary excitation of the parental feelings by some physical modification of the corporeal organs, thus for a time powerfully predominates, its manifestations are, nevertheless, frequently influenced by the active cooperation of the intellectual faculties, as in the following examples.

"The Flycatcher," says Mr. White*, "builds every year in the vines that grow on the walls of my house. A pair of these little birds had one year inadvertently placed their nest on a naked bough, perhaps in a shady time, not being aware of the inconvenience that followed. But a hot sunny season coming on before the brood was half fledged, the reflection of the wall became insupportable, and must inevitably have destroyed the tender young had not affection suggested an expedient and prompted the parent birds to hover over the nest all the hotter hours, while, with wings expanded and mouths gaping for breath, they screened off the heat from their suffering offspring."

"A further instance," continues the same author†, "I once saw of notable sagacity in a Willow-Wren,

* 'Natural History of Selborne,' p. 151.

† Ibid.

which had built in a bank in my fields. This bird a friend and myself had observed as she sat in her nest, but were particularly careful not to disturb her, though we saw she eyed us with some degree of jealousy. Some days after, as we passed that way, we were desirous of remarking how this brood went on: but no nest could be found, till I happened to take up a large bundle of long green moss, as it were carelessly thrown over the nest in order to dodge the eye of any impertinent intruder."

Actuated by a similar motive, old birds which have had their young frequently handled use every art to induce them to desert the nest as early as possible; and I have known the Redbreast on such occasions take off her nestlings long before they could make the slightest use of their wings. That this mode of proceeding must be referred to intelligence, cannot, I think, be doubted, as the danger of allowing their progeny to remain in a state of insecurity is evidently perceived, and the surest means of avoiding it are deliberately adopted in consequence.

Many birds, under particular circumstances, manifest a natural inclination to fight. This disposition is remarkably conspicuous in the Ruff, the Quail, and the Domestic Cock. That the feeling is innate and dependent upon organization is clearly proved by the established fact that careful breeding and training exercise a powerful influence upon the last species with regard to this propensity.

Dr. Darwin states that Pheasants and Partridges teach their young to select and take up their food; and hence he seems disposed to infer that all birds receive instruction in those particulars; but that they are impelled by instinct, independently of education and experience, to exercise the functions of their various corporeal organs, whose structure is admirably adapted to the several offices they have to perform, admits of such numerous and decisive proofs, that it is truly amazing how a person of so much observation as Darwin could have so entirely overlooked them.

Those young birds which do not acquire the use of their eyes for several days after they are hatched open their mouths for food as soon as they are stimulated by hunger, not only when the old ones bring it to them, but when any thing approaches the nest. Nestlings, too, as soon as they are grown sufficiently large, mute over the edge of the nest, though the parent birds carefully convey to a distance whatever drops from them that they do not succeed in ejecting. These actions occur also when birds are brought up in confinement, however young they may be when taken, and therefore must be instinctive.

The Common Duck has its toes connected by a strong membrane, which enables it to swim with facility; and the young of that species, though hatched under birds which instinctively avoid committing themselves to the water, rush to it with

avidity almost as soon as they are extricated from the shell, notwithstanding the utmost exertions of the foster-mother to divert them from it.

Young Swifts are rarely, if ever, observed to perch; and as they cannot easily be distinguished from old ones by their flight, they must display a considerable command of wing the very first time they quit the nest.

Many of the Gallinaceous tribe scratch up the earth with their feet in search of food, and they will frequently repeat this action, when fed, on a stone or boarded floor, where it can answer no useful purpose. Now, as they do not correct this error, it is plain that the action itself does not originate in observation, experience, or reflection; neither can it be attributed to education; nor is this particular misapplication of it to be ascribed to the force of habit, as it may often be observed in very young chickens which have never associated with others of their kind. But, what is still more to the purpose, and, indeed, decisive of the general question, even Pheasants and Partridges, as well as Ducks, Chickens, Turkeys, and Guinea-fowls, which have been hatched by artificial heat, possess the instincts peculiar to their respective species, as I have had several opportunities of ascertaining. How young birds, by their struggles in the egg, can at all facilitate the use of their legs, as Dr. Darwin conjectured, is to me inconceivable, especially when the position in which they lie is taken into con-

sideration. But, even supposing this notion to be correct, it does not in the least affect the instinctiveness of the act, unless we conclude, with Darwin, that instinct has nothing to do with any of those actions which result from the repeated efforts of the muscles under the conduct of the sensations or desires—an opinion so manifestly erroneous that it does not require a formal refutation.

The habits and manners of birds are sometimes so greatly modified by the exercise of the intellectual faculties, that in many cases it becomes extremely difficult, if not impossible, to determine what is due to their influence; but that no small portion of intelligence is exhibited in the following instances will scarcely be denied.

The White-headed Eagle and several of the Gulls, which prey upon the finny inhabitants of the waters, frequently save themselves the trouble of fishing by robbing their more expert and less powerful congeners of the fruits of their industry, occasionally compelling the objects of their violence even to disgorge their undigested food *.

* The late John James Audubon, Esq., the celebrated author of the splendid work on 'American Ornithology,' informed me that when the White-headed Eagle pursues the Fish-Hawk or Osprey for the purpose of depriving it of its prey, it does not, in the first instance, attempt to rise above it, as stated by Wilson in his 'Ornithology of the United States of America,' vol. iv. pp. 90 & 91, but, following it closely, urges it from below to as great an elevation as possible,

The Pied and Yellow Wagtails run close to the legs and noses of cattle which are grazing, in pursuit of the insects disturbed by them: the same motive also induces these and many other birds to follow the husbandman when he is busy with the plough or harrow; and the Redbreast attends the gardener in his labours, and seizes the worms which he turns up with his spade.

Mr. White* states that the Great Titmouse in severe weather frequents houses, and in deep snows, as it hangs with its back downwards, draws straws lengthwise from the eaves of those buildings which are thatched, in order to pull out the flies that are concealed between them; and I have seen Hooded Crows, on the eastern coast of Ireland, after many unavailing efforts to break with their beaks some of the mussels on which they were feeding, fly with them to a great height in the air, and, by letting them fall on the stony beach, fracture their shells, and thus get possession of the contents. Perhaps it would not be easy to select a more striking example of intelligence among the feathered tribes than this, where, on one expedient proving unsuccessful after a

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in order that when the Hawk quits its prize it may be able to secure the fish before it reaches the water. As the Fish-Hawks are not capable of contending individually with the White-headed Eagle, they sometimes combine together in considerable numbers to expel the marauder from their haunts.

* 'Natural History of Selborne,' p. 106.

sufficient trial had been made of it, another was immediately resorted to.

Chickens, in their early attempts to catch flies and other winged insects, show little or no address; but repeated failures teach them to use more circumspection, and they soon learn to distinguish between an active vigilant prey and the inanimate substances on which they likewise feed. This cautiousness of proceeding is clearly the effect of information obtained by experience, and affords an example of an instinctive power being excited to activity by the intellect; but a still more extraordinary instance of acquired knowledge is given by Montagu, in the Supplement to the 'Ornithological Dictionary.' This gentleman observed two Crows by the sea-shore employed in removing some small fish (the refuse of a fisherman's net) from the edge of the flowing tide. They carried them, one by one, just above high-water mark, and there deposited them under large stones or broken fragments of rocks, after having amply satisfied the immediate calls of hunger. Now it must be conceded that these birds were aware that the advancing flood would sweep away their prize unless they conveyed it beyond the limit of its usual rise, or their conduct is quite inexplicable. It is equally plain that this knowledge, in the practical application of which they manifested so much foresight and sagacity, could be derived from observation and experience only; because if it originated in a blind

instinct, it would be common to every individual of the species, and consequently often displayed; whereas, although I have seen hundreds of Crows feeding in situations similar to that above described, I never perceived any of them resort to this effectual means of preserving their prey from the encroaching waters; and I believe the instance related by Montagu is solitary in the records of ornithology.

This propensity to hide the food it cannot devour is not, however, peculiar to the Crow. I have noticed it in the Raven and Magpie; and Rooks, in the autumn, frequently bury acorns in the earth, probably with the intention of having recourse to them when their wants are more urgent; but sometimes forgetting where they have concealed them, they germinate, and not unfrequently excite surprise by the singularity of the situations in which they grow, far distant from any trees by which they could have been produced, and where it is very evident that they have not been planted by man.

It may be proper to remark here, in order to obviate misapprehension, that notwithstanding the circumstances attending this seemingly provident mode of securing a supply of food against a future occasion sometimes afford unequivocal evidence of an intelligent and discerning agent, yet the act of hiding is induced by a purely instinctive propensity. This will be admitted by every one who considers that the species of birds which are remarkable for this pecu-

liarity practise it, however well they may be fed, when brought up from the nest in a state of domestication.

In addition to the numerous proofs of the intelligence of birds already given, I may mention their susceptibility of receiving instruction by education. Thus Eagles, Falcons, and Hawks have been trained to limit the effects of their instinctive propensity to kill to a particular species of game, and to return to the call and lure of the Falconer after having struck down the quarry. The Cormorant, too, was formerly employed with success in taking fish. Here, then, not only great attachment to their keepers and much docility of disposition are evinced by birds which are naturally wild and voracious, but a considerable share of memory is displayed, and a surprising degree of control exercised over some of their most active instincts.

Several birds of the Finch, Grosbeak, and Warbler genera acquire the art of piping long and difficult tunes with facility and precision; and it is well known that some of the Parrots, and also the Jay, Starling, Jackdaw, and Magpie, readily learn to pronounce single words, and even short sentences, with tolerable exactness. Yet, although I have had excellent opportunities of observing the last species, and have been almost in the daily practice of investigating its habits, I never knew it display any unusual exertion of its capacity for imitation in a state of nature,

though when domesticated it appears to have this faculty more highly developed than almost any other British bird.

The congregating of gregarious birds, which takes place in autumn when they have finished breeding, is perhaps intended to promote their mutual security, as they are much less liable to be surprised by enemies when associated together in large numbers than they are when separate. What tends to strengthen this opinion is the fact that some species provide for the general safety by appointing sentinels to give notice of approaching danger. This social disposition, which (with the well-known exception of Rooks) usually continues no longer than the next pairing-season, seems, from the uniformity of the actions that result from it, to be of instinctive origin, though it certainly would be difficult to bring any direct proof that such is the case.

In treating of the migration of birds, Dr. Darwin observes that as all species are capable of remaining throughout the year in those countries in which they were bred, any departure from them must be unnecessary, and therefore cannot be instinctive. This reasoning, however, is extremely fallacious, inasmuch as it restricts the operations of instinct solely to what is necessary; whereas we have seen that the singing of birds and the practice of concealing their superfluous food, though not absolutely indispensable, are, nevertheless, decidedly instinctive. It is, moreover,

built on the gratuitous assumption that several of the Periodical Summer Birds, as the Swallow, Spotted Flycatcher, Cuckoo, Goatsucker, &c., which feed almost entirely on insects, and consequently would not be able to procure a sufficient supply of nourishment in the winter months, have the property of passing the cold season in a state of torpidity—an hypothesis directly at variance with well-established facts. Indeed, how very defective and unsatisfactory the arguments advanced in support of the hybernating system are does not require insisting upon, as those who have considered the subject impartially must be well aware that they are almost wholly founded on the hearsay reports of ignorant and credulous persons.

The history of the Cuckoo proves most incontrovertibly that the desire to migrate, in that species, is instinctive, since nearly all the young ones brought up annually in the north of Europe quit it without receiving the least instruction that such a proceeding is requisite, and without any guide to direct them in their novel undertaking. But I forbear to dwell on the instincts of that extraordinary bird, partly on account of their being so very anomalous, but chiefly because I have already considered them at length*. The highly curious fact that the Swallow, House-Martin, Sand-Martin, and Puffin sometimes leave their last-hatched broods to die of hunger in the nest, in order to accompany their species in their

* See observations on the Cuckoo, p. 49.

autumnal migration, is alone sufficient to establish the instinctiveness of that inclination which can thus overcome their parental affection—a feeling so energetic as frequently to counteract one of the most powerful laws of nature, self-preservation. No theory, in short, which is not founded on the opinion that birds of passage, in undertaking their annual journeys, are influenced by an instinctive desire to migrate, liable to be called into action by various exciting causes, can satisfactorily account for the remarkable phenomena which result from this periodical disposition to wander.

The certainty with which the Carrier Pigeon directs its course towards its accustomed home from distant places where it has never been before, after every precaution has been taken in its conveyance to prevent it from obtaining any knowledge of the way by observation, must, as well as the act of migration, to which it bears a striking resemblance, be likewise attributed to instinct*.

* Some birds, though not migratory, occasionally undertake long journeys, in which they cross extensive tracts of water. On the 16th of March, 1823, at noonday, my father saw, from the deck of the 'Vixen,' steam-packet, bound for Holyhead, being then near mid-channel, about thirty Rooks winging their course towards the Irish coast, and, almost an hour after, five others were observed following in the same direction. The flight of these birds was low, silent, and direct; a steady breeze from the east was blowing at the time, and they passed within a short distance of the vessel.

It appears, then, from the foregoing observations, that the principal actions of birds, though liable to be considerably modified by the operations of the intellectual powers and changes of organization, as well as by various external circumstances, are, contrary to the opinion of Dr. Darwin, decidedly of instinctive origin. Many additional arguments might be advanced, and a multitude of highly respectable authorities quoted in support of this doctrine; but, conceiving that sufficient evidence has been already produced, I shall only add that I am not aware of any serious objection which can be urged against it.

OBSERVATIONS ON

THE PIED FLYCATCHER.

In directing the attention of ornithologists to a favourite haunt of the Pied Flycatcher, I am not without hope that some individual who has leisure for the undertaking may be stimulated to investigate the manners and economy of this interesting species, with a greater degree of minuteness than has hitherto been done. The elucidation of several doubtful points in its history could not fail to reward his industry, and promote the interests of natural science.

On the 3rd of June, 1828, I procured a male Pied Flycatcher in the woods near the ferry-house on the western shore of Windermere, where I saw two males and a female. The female and one of the males had paired, and were occupied in constructing a nest in a hole in a decayed pollard ash on the margin of the lake. But the vicinity of Ullswater appears to be the favourite resort of this species; as, in walking on the 1st of June from the water-head to Gowbarrow Old Park, on the western side of the lake, a distance not exceeding three miles, I saw,

without quitting the carriage road, five males at five separate stations, which were distinctly marked by large pollard ashes partially decayed. To these spots the birds were evidently much attached, reluctantly retiring from them to a short distance when greatly disturbed, and immediately returning again when the cause of their alarm was removed. This circumstance led me to suppose that they had nests; and, as I did not observe a single female, it is probable that they were engaged in incubating their eggs or in brooding their young. The males were all in full song, and their notes, which were sometimes, though rarely, delivered on the wing, were lively and pleasing.

Ornithologists do not seem to be acquainted with the extent of the vocal powers possessed by this species. According to Dr. Latham ('General History of Birds,' vol. vi.), Mr. Bolton, the author of 'Harmonia Ruralis,' has remarked that the song of the male, which is heard in the breeding-season, resembles that of the Spotted Flycatcher, but that it is more sprightly and energetic. The comparison is an unfortunate one, and may have induced a belief that the Pied Flycatcher has no song whatever, as the spotted species is one of our most silent birds. I am happy, therefore, in being able to claim for the Pied Flycatcher a place among British Singing Birds.

Montagu and Latham have regarded the Pied Flycatcher as indigenous to England: several distinguished ornithologists, on the other hand, have

considered it to be an occasional visitor merely: this latter opinion, however, must be abandoned, as it certainly breeds year by year in the woods on the borders of Ullswater. The prevalence of the idea that this species does not migrate may be attributed principally to the assertion of Montagu, that it "rarely, if ever, makes its appearance in the southern parts of the island" (see the Supplement to the 'Ornithological Dictionary'); but Messrs. Sheppard and Whitear, in their "Catalogue of the Norfolk and Suffolk Birds," published in the 'Transactions of the Linnean Society,' vol. xv. part 1, state, that they have "seen a specimen of this bird which was killed near Cromer," that "two others were caught by Mr. Downes in his garden at Gunton, in Suffolk, and a fourth was shot at Keswick, near Norwich." Mr. Selby, also, in his 'Illustrations of British Ornithology,' informs us that he has seen specimens from Dorsetshire; consequently Montagu's observation loses much of its force; indeed, as the habits of this bird indicate that it preys chiefly on insects in their winged or perfect state, there can be little doubt that it is migratory: a sufficient reason, however, why the fact has not been more clearly ascertained will be found in its great rarity and partial distribution. In Lancashire I have never seen this species earlier in the year than April, nor later than September.

I have long known that the Pied Flycatcher breeds

annually in the beautiful woods near Ullswater; but I was not aware, before the summer of 1828, that it is to be found in such abundance in that delightful locality. Subsequently I have discovered that this species is to be seen every summer sparingly dispersed throughout the entire extent of the valley of the Conway, North Wales.

For a long series of years a pair of Pied Flycatchers had incubated their eggs and nurtured their young in security in a small aperture close by the portico to the principal entrance of my father's residence, Hendre House, Denbighshire, undisturbed, apparently, by the frequent passing and repassing of its inmates. The lively effect of the well-defined and strongly contrasted black-and-white plumage of the male, his short but pleasant song, and the confiding habits of both sexes rendered them objects of great interest to all the members of the family, who did not allow them to be molested on any pretext whatever. Unfortunately, on the 18th of June, 1843, a swarm of bees discovered the aperture, which then contained a brood of nestlings nearly fledged, and by hurrying in and out of it and flying about the entrance in large numbers, seemed determined to dispossess the rightful owners. Whenever the parent birds attempted to approach the spot for the purpose of feeding their young, they were instantly attacked and repelled by the excited bees, from which they took refuge among the branches of an oak growing

near, and there manifested their anxiety by notes and actions expressive of extreme uneasiness. After having been severely stung, the nestlings fluttered to the mouth of the aperture and fell to the ground, where they all perished, their bodies being much swollen.

Towards the close of April 1844 the same pair of birds returned to their favourite breeding-haunt, and repeatedly visited the aperture so long occupied by their nest; but being again assailed by the bees, which had removed to a parallel aperture on the other side of the portico, it is probable that the incident recalled the destruction of their progeny in the preceding year; for they eventually deserted the place, and selected a hole in a low stone wall by the side of the avenue leading to the house, in which they constructed a nest and brought up their young.

This instance (and other cases might be adduced) evidently tends to show that the Pied Flycatcher resorts annually to the same locality for the purpose of continuing its species, and that, like its congener the Spotted Flycatcher, it is a very familiar bird during the breeding-season.

A BRIEF NOTICE OF

BEWICK'S SWAN.

From an examination of the various specimens of Swans contained in the Manchester Museum (two of which are Whistling Swans or Hoopers, one in mature and the other in immature plumage, and a third is the *Cygnus Bewickii* of Mr. Yarrell, described in the 'Transactions of the Linnean Society,' vol. xvi. p. 445 *et seq.*) I had, for several years, strongly suspected that there are two distinct species of the genus *Cygnus* which occasionally visit this country. But, notwithstanding the comparatively small size of the last-mentioned bird, its more clumsy figure, and the snowy whiteness of its plumage, which indicates maturity, in general appearance it bears so striking a resemblance to the Hooper, that I hesitated to announce it as a new species previously to having made myself acquainted in some measure with its habits and internal organization, no opportunity of investigating which had hitherto presented itself.

My attention was again directed to this in-

teresting subject, and my former suspicion corroborated, by a remarkable circumstance that occurred in the neighbourhood in which I formerly resided. About half-past eight on the morning of the 10th of December, 1829, a flock of twenty-nine Swans, mistaken, by many persons who saw them, for Wild Geese, was observed flying over the township of Crumpsall, at an elevation of about fifty yards above the surface of the earth. They flew in a line, taking a northerly direction, and their loud calls (for they were very clamorous when on wing) might be heard to a considerable distance. I afterwards learned that they alighted on an extensive reservoir, near Middleton, belonging to Messrs. Burton and Sons, calico-printers, where they were shot at; and an individual had one of its wings so severely injured that it was disabled from accompanying its companions in their retreat.

A short time after I had an opportunity of seeing the wounded bird, which resembled the rest of the flock with which it had been associated, and found, as I had anticipated, that it was precisely similar to the small Swan preserved in the Museum at Manchester, which, I should state, was purchased in the fish-market in that town.

Twenty-nine of these birds congregated together, without a single Whistling Swan among them, is a fact so decisive of the distinctness of this species, especially when taken in connexion with those ex-

ternal characters in which it differs from the Hooper, that I should no longer have deferred to describe it as a new bird to ornithologists had I not been anticipated by Mr. Yarrell.

Of the habits and manners of this species little could be ascertained from a brief inspection of a wounded individual; I may remark, however, that, when on the water, it had somewhat the air and appearance of a Goose, being almost wholly devoid of that grace and majesty by which the Mute Swan is so advantageously distinguished. It appeared to be a shy and timid bird, and could only be approached near by stratagem, when it intimated its apprehension by uttering its call. It carefully avoided the society of a Mute Swan which was on the same piece of water.

On the 28th of February, 1830, at half-past ten A.M., seventy-three Swans were observed flying over Crumpsall in a south-easterly direction at a considerable elevation. They flew abreast, forming an extensive line like those seen on the 10th of December, 1829; like them, too, they were mistaken for Wild Geese by most persons who saw them with whom I had an opportunity of conversing on the subject; but their superior dimensions, the whiteness of their plumage, their black feet, easily distinguished as they passed overhead, and their reiterated calls, which first directed my attention to them, were so strikingly characteristic that skilful

ornithologists could not be deceived with regard to the genus to which they belonged.

That these birds were not Hoopers may be safely inferred from their great inferiority in point of size. Now the circumstance of the small Swans associating together in large numbers, unaccompanied by Hoopers (the only British species with which they could be confounded by naturalists), and the difference pointed out by Mr. Yarrell in their internal structure are facts which completely establish their specific distinctness.

I am informed that when the Wild Swans were shot at near Middleton, on the 10th of December, 1829, one of them was so reluctant to abandon the bird which was wounded on that occasion, that it continued to fly about the spot for several hours after the rest of the flock had departed, and that during the whole of this period its mournful cry was heard almost incessantly. In consequence of the protracted disturbance caused by the persevering efforts of Messrs. Burton's workmen to secure its unfortunate companion, it was at last compelled to withdraw, and was not seen again till the 23rd of March, when a Swan, supposed to be the same individual, made its appearance in the neighbourhood, flew several times round the reservoir in lofty circles, and ultimately descended to the wounded bird, with which, after a cordial greeting, it immediately paired. The newly arrived Swan, which proved to be a male

bird, soon became accustomed to the presence of strangers, and when I saw it on the 4th of April, 1830, was even more familiar than its captive mate. As these birds were strongly attached to each other and seemed to be perfectly reconciled to their situation, which in many respects was an exceedingly favourable one, there was every reason to believe that a brood would be obtained from them. This expectation, however, was not destined to be realized. On the 13th of April, 1830, the male Swan, alarmed by some strange dogs which found their way to the reservoir, took flight and did not return; and on the 5th of September, in the same year, the female bird, whose injured wing had recovered its original vigour, quitted the scene of its misfortunes and was seen no more.

ON

A REMARKABLE FORMATION OF THE BILL

OBSERVED IN SEVERAL SPECIES OF BIRDS.

INSTANCES of extraordinary deviation from typical forms in the structure of animated beings are highly interesting to the physiologist, whether his attention be directed to the influence which organic modifications exercise upon the animal economy, or to the more abstruse investigation of the predisposing causes of these curious phenomena. Such being the case, a concise account of a few examples of this nature, which have come to my knowledge, will, it is presumed, require no apology.

A Jackdaw, killed at Bowers, in the parish of Standon, Staffordshire, was presented, in January 1830, to the Society for the Promotion of Natural History, established in Manchester, and is deposited in their Museum. This bird, in the structure of its bill, presents a form closely resembling that which so strikingly characterizes the species constituting the genus *Loxia*, the mandibles crossing each other at some distance from their points, the upper one

curving downward on the right side of the lower one, which takes an upward direction to the left. The preternatural elongation of the mandibles, in conjunction with a considerable degree of curvature, gives to this individual (which, on dissection, proved to be a male) a peculiar physiognomical expression, and must have contributed greatly to modify its manner of feeding; the contents of the stomach, however, were so changed by maceration, that it was not possible to determine by inspection of what they consisted. I may remark that this bird was in excellent condition, notwithstanding the inclemency of the season, a convincing proof that it had acquired much expertness in the management of its singularly formed bill.

A Rook, also preserved in the Manchester Museum, has its mandibles crossed near their extremities, but so slightly as not to have interfered materially with the mode of procuring food usually employed by that species, as is clearly evinced by the denuded state of the nostrils and the anterior part of the head, both of which are entirely destitute of feathers. Another specimen which was in the possession of the late Mr. R. Wood, a zealous collector of objects in natural history, residing in Manchester, had the mandibles greatly elongated and much curved, as in the case of the Jackdaw detailed above. Now it is evident that the bird possessing a bill thus formed could not thrust it into the ground in search of worms and

the larvæ of insects, as the Rook is known to do habitually; and, accordingly, the plumage at the base of the bill of this individual, and the bristly feathers which cover its nostrils, are very conspicuous, not having sustained the slightest injury.

The last instance of this anomalous structure of the bill which has fallen under my observation occurred in a specimen of the Red-headed Woodpecker (*Picus erythrocephalus*, Linn.) contained in a collection of birds' skins lately brought from the United States of North America. In this individual the mandibles, though pretty much elongated, are but slightly curved, the upper one, as in the preceding cases (Mr. Wood's Rook alone excepted, in which the direction is reversed), crossing the lower one on the right side. A bill so constructed must have proved exceedingly inconvenient to a bird of this species.

I might now proceed to speculate upon the circumstances which contributed to produce this phenomenon; but as my acquaintance with the history of the birds in which I have seen it exhibited is so imperfect, that any thing I could advance concerning them would be little more than conjectural, I shall not enter into the inquiry.

ON THE NUDITY OF THE ANTERIOR PART OF

THE HEAD OF THE ROOK

(*Corvus frugilegus*).

Bewick, in treating upon the Rook in his 'History of British Birds,' vol. i. p. 71, has remarked that he is inclined to regard the naked condition of the base of the bill and the anterior region of the head in this species as an original peculiarity, apparently intending to intimate thereby a belief that at no period of its existence are the parts in question covered with feathers—a construction of the passage which is countenanced by his having omitted to notice the fact that young Rooks, before their first moult, do not exhibit this deficiency of plumage. Now as young Rooks, when they quit the nest, have the base of the bill and the anterior part of the head amply provided with feathers, the question naturally arises, how is the nudity of these parts in old birds occasioned?

In the year 1834, I advocated the opinion, prevalent among ornithologists, that the loss of the feathers alluded to above is attributable to the habit which

the Rook has of thrusting its bill into the ground in search of food. An extensive examination and comparison of specimens had led me to observe that the nudity extends further and is more complete in some individuals than in others, that the more prominent and exposed parts are first deprived of feathers, and that short filiform processes, bearing a close resemblance to new feathers enveloped in membrane, frequently occur on the less prominent and less exposed parts, particularly on the flaccid skin which occupies the angle at the base of the lower mandible. In addition to these facts, I may remark that an opportunity had presented itself of inspecting a Rook whose mandibles were so greatly curved in opposite directions, and, consequently, so much crossed at the extremities, that it could not possibly thrust its bill into the ground; and the base of that organ and the anterior part of the head did not manifest the least deficiency of plumage. With such evidence in its favour, I was induced to adopt the popular hypothesis, which I now abandon in consequence of having recently proved by experiment that it is erroneous.

Being supplied by George Davies, Esq., with two young Rooks, taken from a nest in his rookery at Cyffdy on the 17th of May, 1843, I put them into a large wooden chicken-pen, purposing, when they could take their food without assistance, to remove one of them to a garden enclosed with walls,

where it might have an opportunity of employing the means of procuring sustenance common to the species, and to let the other remain in the pen. This plan was frustrated by the unexpected death of one of the young birds soon after it came into my possession; but the result of the experiment, as will be seen in the sequel, was not at all affected by this untoward circumstance. In the month of August the surviving Rook lost only a few feathers from various parts of its body, but did not moult regularly till July and August, 1844, when the feathers at the base of the bill and on the anterior region of the head were cast off, and were not renewed, though the bird was remarkably healthy and was never, on any occasion, suffered to leave the pen for a moment. On the 20th of June, 1846, an unfortunate accident terminated its existence. It lived long enough, however, thoroughly to establish the fact, that after the feathers are once shed from those parts in the act of moulting they are not renewed, as the denudation became rather more extensive and complete after the bird had moulted a second time in the summer of 1845, and continued unchanged to the day of its death, affording a convincing proof that this conspicuous feature in the adult Rook, which strikingly affects its physiognomical expression, must be regarded as a specific character.

That Rooks in a state of liberty usually moult in the autumn of the year in which they are disengaged

from the egg may be inferred from the fact that although numerous individuals, whose shrill voices evidently denote that they are young birds of the season, may be seen in the months of June and July with the base of the bill and anterior part of the head abundantly supplied with feathers, yet for several months prior to the breeding-season not one can be perceived, at least as far as my own observations extend, which has not those parts denuded.

From what has been stated, it is evident that the phenomenon under consideration has a physiological, not a mechanical cause, though the removal of the plumage may be facilitated by the frequently repeated act of thrusting the bill into the ground; and the circumstances which seemed to support the opposite conclusion admit, for the most part, of an easy explanation upon this view of the subject. The difference observable in the extent and completeness of the nudity at the base of the bill and the anterior part of the head of the Rook probably depends upon the progress which has been made in moulting, especially among the younger birds; and the earlier denudation of the more prominent parts may be occasioned by the friction consequent upon the manner in which the bill is employed in procuring food. The short filiform processes so common on the depressed and less exposed parts present a difficulty of which no satisfactory solution suggests itself; but the state of the plumage on the head of

that Rook whose mandibles were greatly crossed may be accounted for on the supposition that it was a young bird which had not moulted.

Had the experiment recorded by Mr. Waterton in his 'Essays on Natural History,' pp. 136–139, been successful, this question, upon which public opinion has been so long divided, would have been settled some years earlier; unfortunately, however, both the young Rooks selected for the purpose of deciding it met with untimely deaths, one before it had begun to moult, and the other soon after it had commenced moulting. On Mr. Waterton's return from Bavaria, his gamekeeper, to whose care the latter bird had been consigned, informed him that at the period when its existence terminated "the lower mandible had begun to put on a white scurfy appearance, while here and there a few feathers had fallen from the upper one." It is to be regretted that the issue of this experiment was not more satisfactory, as from the nature of the case it was impossible to determine whether the feathers lost from the base of the bill would be renewed or not, though feathers shed from other parts in the act of moulting are known to be reproduced.

The Rook visits orchards and gardens when cherries and walnuts are ripe, for the purpose of feeding on those fruits; it also devours grain of various kinds, and frequently commits depredations in potato-grounds by abstracting the newly-planted sets; but I

entirely concur with those naturalists who maintain that the injuries it inflicts on the farmer and gardener are vastly more than compensated by the benefits it confers upon them by the destruction of noxious insects.

REMARKS

ON

THE DIVING OF AQUATIC BIRDS.

"The superior velocity with which Aquatic Birds swim under water has not wholly escaped notice; but it is not entirely produced by the action of the wings, which are sometimes used as fins to accelerate the motion, but is occasioned by the pressure of the water above. In swimming on the surface a bird has two motions (one upwards, the other forward) at every stroke of the feet; so that, when covered with water, that force which was lost by the upward motion is all directed to the progressive, by which it is enabled to pursue its prey or to escape an enemy with incredible speed."

Many years since, when perusing, for the first time, the foregoing observations on the diving of Water-fowl, contained in the Introduction to Montagu's 'Ornithological Dictionary,' pp. xxxix & xl, the insufficiency of the author's attempt to solve this

problem in natural history was perceived, and I was induced to make a few comments on the subject in my zoological note-book. It is probable, however, that they never would have filled a more conspicuous situation than that which they so long occupied in its pages had not my attention been again directed to them by Dr. Drummond's introduction of Montagu's hypothesis, which is directly opposed to the established principles of dynamics, in his interesting 'Letters to a young Naturalist.'

It is asserted by the advocates of this hypothesis that the action of the legs in diving not only gives to birds a progressive motion, but also a tendency to rise; which tendency being overcome by the pressure of the water above them, the entire moving force is directed in the line of the body, accelerating thereby the velocity with which they pursue their subaqueous course.

Now, it is a law of hydrostatics that the pressure of fluids in a state of equilibrium is equal in all directions at the same depth: whatever obstacle, therefore, the circumstance of pressure may present to the ascent of a bird when diving it must also present, *cæteris paribus*, to its progressive motion.

Moreover, it is manifest, from the exceeding facility with which the particles of water move among one another, that if any tendency upwards did result from the action of the limbs of Water-fowl in diving,

it could not be wholly counteracted by the pressure of the mass of fluid above them: indeed, the specific gravity of such birds being less than that of water, it would not be possible for them to continue beneath its surface, even for a much shorter period than they are known to do, without the employment of physical force to effect their purpose; hence the fallaciousness of the argument that the propelling power is increased on such occasions by the pressure of the superincumbent water, is rendered sufficiently obvious.

It remains to consider what means are actually made use of by birds in diving to overcome the resistance of the medium in which they move, and the tendency upwards arising from their small specific gravity; and as Mr. White has illustrated this subject in his usual felicitous manner, in treating upon the Northern Diver (*Colymbus glacialis*, Linn.), in the second volume of the octavo edition of his 'Works in Natural History,' pp. 184–186, I cannot do better than avail myself of his observations.

"Every part and proportion of this bird (the Northern Diver) is so incomparably adapted to its mode of life, that in no instance do we see the wisdom of God in the creation to more advantage. The head is sharp and smaller than the part of the neck adjoining, in order that it may pierce the water; the wings are placed forward and out of the centre

of gravity for a purpose which shall be noticed hereafter; the thighs quite at the podex, in order to facilitate diving; and the legs are flat, and as sharp backwards almost as the edge of a knife, that in striking they may easily cut the water; while the feet are palmated and broad for swimming, yet so folded up when advanced forward to take a fresh stroke, as to be full as narrow as the shank. The two exterior toes of the feet are longest; the nails flat and broad, resembling the human, which give strength and increase the power of swimming. The foot, when expanded, is not at right angles to the leg or body of the bird; but the exterior part inclining towards the head forms an acute angle with the body, the intention being not to give motion in the line of the legs themselves, but, by the combined impulse of both, in an intermediate line, the line of the body.

"Most people know, that have observed at all, that the swimming of birds is nothing more than a walking in the water, where one foot succeeds the other as on the land; yet no one, as far as I am aware, has remarked that Diving Fowls, while under water, impel and row themselves forward by a motion of their wings as well as by the impulse of their feet; but such is really the case, as any person may easily be convinced who will observe Ducks when hunted by dogs in a clear pond. Nor do I know that any one has given a reason why the

wings of Diving Fowls are placed so forward: doubtless not for the purpose of promoting their speed in flying, since that position certainly impedes it; but probably for the increase of their motion under water, by the use of four oars instead of two; yet were the wings and feet nearer together, as in land birds, they would, when in action, rather hinder than assist one another."

Mr. White's description of the manner in which the Northern Diver impels itself through the water by the agency of the legs, which have an extent of motion enabling it to alter its course in any direction whatever with astonishing facility, is applicable to Diving Birds in general; but it does not appear that the wings are so uniformly employed to promote their progress, when submerged, as the statement of the natural historian of Selborne would seem to imply.

I may remark, in conclusion, that the action of the legs in diving, so far from giving birds an impulse *upwards* and forwards, as Montagu has affirmed, evidently tends rather to propel them *downwards* and forwards, except when they purpose to ascend, and then a change of action, adapted to the accomplishment of the object to be attained, is instantly resorted to. The simultaneous action of the legs also, directing the impelling power in the line of the body, will explain why the velocity with which Aquatic Birds move in so dense a fluid as water is

greater than that with which they move on its surface, where the legs are usually employed alternately, and the moving force cannot be so advantageously applied; and that the velocity is frequently accelerated still further by the instrumentality of the wings, has been already noticed.

Thus, in controverting the erroneous opinions of Montagu relative to the diving of Water-fowl, I have endeavoured to substitute for them an unobjectionable theory of this remarkable phenomenon.

SOME ACCOUNT

OF THE

MANNERS OF THE GRENADIER GROSBEAK

(*Loxia oryx*, Linn.)

WHEN IN CAPTIVITY.

DURING a visit to the aviary of the late Mr. Garside, at his residence in Piccadilly, Manchester, I noticed, among various objects of attraction to the bird-fancier, such as piping Bullfinches, loquacious Starlings, and superb Parrakeets, which displayed powers of imitation as astonishing as they were entertaining, several choice exotic birds, whose habits and notes afforded me much gratification. A fine male Grenadier Grosbeak, in particular, engaged my attention: I say a male, although it had not the black plumage on the throat which Dr. Latham seems disposed to regard as a characteristic of that sex; for Barrow, in his 'Travels into the Interior of Southern Africa,' vol. i. p. 243, distinctly states that "the male is remarkable for its gaudy plumage during the spring and summer months;" and, again,

"during the other six months it is stripped of its gaudy attire, and adopts the modest garb of the female, which is at all times that of a greyish brown." Now the animal economy of the individual under consideration confirmed the correctness of Barrow's observations, as I was informed by Mr. Garside that it changed its feathers twice in the course of the year: the first moult occurred about May, when it acquired the splendid livery of the pairing-season, and the second in November, at which period its gay wedding-dress was laid aside for a homely suit of brown of various shades. In short, so complete was the metamorphosis (the bill itself undergoing a change of colour), that its specific identity would have been called in question by any person unacquainted with these particulars in its history. It is probable, therefore, that the black plumage on the throat may indicate maturity, or it may conveniently be ascribed to the influence of circumstances which in our ignorance we term accidental.

Another fact, tending to corroborate the opinion that this bird was a male, deserves consideration; it had a song, and a most extraordinary one it was. Elevating the brilliant red feathers on the back of its neck, and raising itself on its perch till it assumed an attidude so perpendicular that it appeared to be in danger of falling backwards, it commenced its lay by uttering one or two sharp chirps, which were followed by a chattering sound produced by the

hurried repetition of the same note; to this succeeded a sort of snapping noise, similar to that occasioned by bringing the open mandibles into sudden contact, and the *finale* consisted of a protracted sound, enforced with considerable emphasis at regular intervals, somewhat resembling the sibilation which results from the grinding of scissors. Mr. Audubon, the celebrated American ornithologist, who saw this bird when he was last in Manchester, compared the concluding part of its song to the sound produced by the brisk agitation of the tail of the Rattlesnake. While pouring forth its discordant strains, this grotesque vocalist would frequently raise its wings, expand them in a slight degree, and again bring them into their ordinary position of repose. It would also approach slowly towards any of its companions in captivity which happened to occupy the same perch with itself, and endeavour to touch them with its bill, as if it were desirous to elicit their attention in particular to its strange music, which, in conjunction with its fierce deportment, had usually the effect of exciting consternation in that portion of its audience.

For the purpose of calling into action one of the most singular instincts with which this bird was endowed, Mr. Garside supplied it with a little thread. No sooner had it obtained the prize than a Dominican Grosbeak (*Loxia dominicana*, Linn.) hastened to dispute its right of possession. Erecting the feathers on the back of its neck, and uttering a few angry

chirps, the Grenadier Grosbeak threw itself into one of its most menacing attitudes, in order to intimidate the insolent aggressor; but, notwithstanding all these formidable indications of resistance, it was compelled to yield the object of contention to its more powerful adversary, which, after carrying it about the cage for a short time, became tired of the amusement and suffered it to drop, when it was instantly seized by the vigilant Grenadier Grosbeak. This was the signal for a renewal of hostilities, and several species of *Fringillæ* and *Loxiæ* joined eagerly in the affray; while a few grave-looking birds, belonging to the genera *Palæornis*, *Platycercus*, and *Psittacula*, sat on the upper perches, passive spectators of the turbulent scene below. At length, by dint of perseverance, the Grenadier Grosbeak again succeeded in gaining possession of the thread, one extremity of which it immediately proceeded to attach to the wires of the cage. After accomplishing its object by the employment of the bill alone, it passed the other end of the thread through one of the intervals between the wires, directing it towards the adjoining interval on the right; then quitting hold of it, and inserting its bill into the latter interval, it again seized the thread near its extremity, drew it through the opening and pulled it tight. In this manner it interwove the whole of the thread among the wires of the cage, with a quickness and dexterity quite surprising; and so delighted was the feathered

operative with this engrossing occupation, that it repeatedly demolished its work and renewed it again, varying the direction it gave to the thread as the circumstances of the case seemed to require, the principal object in view, apparently, being the production of a compact tissue. If supplied with a sufficient quantity of thread, Mr. Garside assured me that this industrious bird would speedily cover the sides of the cage with its ingenious work; and so indefatigable was it in procuring materials for the prosecution of its labours, which were not restricted to any particular season of the year, but were pursued even in winter, when it had assumed the garb of the female, that Mr. Garside had been under the necessity of removing a beautiful male Wydah bird (*Vidua paradisea*, Cuvier) into another cage, in order to preserve the long feathers of its tail from the injuries to which they were liable in consequence of the incessant efforts of the Grenadier Grosbeak to appropriate them to its purpose. When about to be attacked by another bird, the Grenadier Grosbeak would sometimes interlace the anterior toes of one of its feet with the thread, the better to secure it, by which contrivance its bill was left at liberty to repel the marauder.

Nothing satisfactory appears to be known concerning the nidification of this species of Grosbeak. If, as Dr. Latham conjectures ('Gen. Hist. of Birds,' vol. v. p. 223), it is identical with Kolben's Finch,

it constructs a nest of small twigs, closely interwoven with cotton, and so compact as not to be penetrated by the weather; but I am not aware that these birds have been ascertained to be specifically the same. The only information relative to this subject given us by Barrow is that the Grenadier Grosbeaks are gregarious, and build their nests in large societies ('Travels into the Interior of Southern Africa,' vol. i. p. 243). It may be safely inferred, however, from what has already been stated with regard to the instinctive propensities manifested by this species when in confinement, that the position it occupies among the heterogeneous forms with which it is associated in the Linnean genus *Loxia* is decidedly inappropriate.

DESCRIPTION OF

FALCO AUDUBONI.

Order *Raptores*, Illiger.
Family *Falconidæ*, Leach.
Subfamily *Falconina*, Vigors.
Genus *Falco*, Linnæus.
Falco Auduboni.

The bill, which is curved from the base, is of a deep blue colour, approaching to black at the tip; the upper mandible is provided with a prominent tooth on each side, a corresponding notch occurring on the under mandible, which is truncated at the extremity. The colour of the cere is yellow. The nostrils are circular, with a tubercle in the centre. The upper part of the head and neck are blackish brown, with a slight tinge of blue; the cheeks and a line above each eye are yellowish white, marked with fine longitudinal streaks of dark brown. On the back of the neck there is an obscure collar of yellowish white, spotted with dark brown. The back, scapulars, tertials, and upper tail-coverts are greyish black, tinged with blue, each feather having a narrow black line down the middle. The upper

wing-coverts are brownish black, faintly tinged with blue. Quill-feathers of the wings brownish black, the inner webs being marked with numerous oval white spots. The first and second primary quills have their inner webs deeply and abruptly emarginated near their extremities; the second and third, which are the longest, are nearly of equal length. Tips of the primaries (the first three excepted) and of the secondaries finely bordered with dull white. The tail is brownish black, tipped with white, and has several narrow transverse bands of a cinereous hue. The chin and throat are white, streaked longitudinally with fine lines of dark brown. Breast, sides, abdomen, and under tail-coverts yellowish white, with longitudinal streaks and spots of a dark brown colour; the largest and roundest spots occur on the sides. Under wing-coverts dark brown, spotted with white. The feathers of the thighs are pale ferruginous, streaked longitudinally with dark brown. The tarsi and toes are yellow, the former being reticulated and the latter scutellated above. Claws black. Colour of the eyes not known.

Length, from the point of the bill to the extremity of the tail, $9\frac{4}{5}$ inches; wings, from the carpal joint to the tip of the second quill-feather, $7\frac{1}{2}$; tail 5; bill, from the point of the upper mandible to the rictus, $\frac{7}{10}$; tarsi $1\frac{3}{10}$; middle toe, including the claw, $1\frac{3}{5}$.

The Museum belonging to the Society for the promotion of Natural History, established in Man-

chester, contains the small Falcon described above, which is probably a male. It was sent to this country from Philadelphia, in a collection of the skins of birds of the United States of North America. It has the closest affinity with the Merlin, but may readily be distinguished from that bird by its smaller size, by the tips of the folded wings approaching nearer to the end of the tail, by the plumage of the upper parts, which is much darker-coloured, resembling that of the Hobby, and also by the plumage of the inferior parts, which has less of the ferruginous tint.

A skin which I obtained from the same collection appears to have belonged to an immature male of this Falcon. It differs from that of the adult male principally in having the plumage of the upper parts of a deep brown colour (with the exception of a few feathers which have assumed the dark bluish tint), and in the oval spots on the inner webs of the quill-feathers of the wings having a pale red-brown hue.

I have dedicated this species to the late J. J. Audubon, Esq., the celebrated author of the 'Ornithological Biography,' whose splendid illustrations of the 'Birds of America,' to use the words of the illustrious Cuvier, constitute the most magnificent monument which has hitherto been raised to ornithology.

DESCRIPTION OF

LAMPROTORNIS VIGORSII.

THERE are deposited in the Manchester Museum two specimens of a bird belonging to the genus *Lamprotornis*. The following brief description will serve to convey some idea, though it must be admitted an inadequate one, of this highly interesting and beautiful bird.

Order *Insessores*, Vigors.
Tribe *Conirostres*, Cuvier.
Family *Sturnidæ*, Vigors.
Subfamily *Lamprotornina*, Stephens.
Genus *Lamprotornis*, Temminck.
Lamprotornis Vigorsii.

The bill and legs are black. The plumage is soft, silky, and glossy. The upper part of the head, sides and back of the neck, anterior region of the back, and lesser wing-coverts are of a burnished golden-green colour; a narrow border of fine purple separates the anterior from the posterior part of the back and from the scapulars, both of which are of a rich golden bronze; greater wing-coverts and feathers of the spurious wings deep purple, relieved with violet-blue and gold; the exterior webs of the quill-feathers of the wings are of a

brilliant golden bronze, those of the primaries and the tips and inner webs of the tertials having a mixture of purple and violet-blue; the tips of the primaries are purple, glossed with violet-blue and green, and the exterior and inner webs of several of the larger quills in each wing are abruptly emarginated, the latter near their termination, a prominent point, formed by the projection of the more elongated fibres of the webs, rendering the sudden transition in their breadth remarkably conspicuous; inner webs of the primaries and secondaries obscure purple, reflecting a faint golden lustre in a powerful light. Tail rounded at its extremity, black, with a slight mixture of golden bronze above, particularly on the middle feathers; tip and outer edges of the lateral feathers purple, resplendent with violet-blue and green; upper and under tail-coverts purple, varied with violet, steel-blue, and green; cheeks purple, tinged with green; throat and anterior part of the neck and breast similar in colour to the scapulars, but less brilliant; abdomen green-bronze, tinged with gold; thighs and flanks purple, blended with violet, gold, and steel-blue; underside of the wings and tail black. Colour of the eyes not known. The tints of the plumage vary considerably in intensity in different specimens.

Length, from the apex of the bill to the extremity of the tail, $11\frac{2}{5}$ inches; wings, from the carpal joint to the tip of the fourth quill-feather, $6\frac{1}{10}$; tail $4\frac{7}{10}$;

bill, from the apex to the forehead $\frac{9}{10}$, to the rictus $1\frac{2}{5}$; tarsi $1\frac{7}{20}$; middle toe, including the claw, $1\frac{1}{5}$; hind toe, including the claw, $\frac{19}{20}$.

As the two individuals of the above species in the Manchester Museum were imported to Liverpool from Brazil, along with a considerable collection of the skins of Brazilian birds, it is possible that this elegant creature may be a native of South America. I have no positive information, however, that such is the fact; and M. Temminck, in treating upon the group to which it belongs (see his 'Manuel d'Ornithologie,' vol. i. p. lv, note 3), remarks that "toutes les espèces sont de l'ancien continent, le plus grand nombre d'Afrique."

I have named this splendid bird in compliment to that distinguished and disinterested naturalist the late N. A. Vigors, Esq., who politely directed my attention to it.

In detailing those peculiarities of structure which characterize the genus *Lamprotornis* M. Temminck says of the toes, "l'interne soudé à sa base, l'externe divisé" (Manuel d'Ornithologie, vol. i. p. lvi), the very reverse of what is actually the case. This error, which probably originated in inadvertency, was repeated by an eminent French zoologist; it becomes the more desirable, therefore, that it should be corrected.

ON THE GROWTH OF THE SALMON

(*Salmo salar*),

AND OF THE SEWIN

(*Salmo cambricus*).

To Mr. John Shaw of Drumlanrig belongs the merit of having successfully developed the natural history of the small fish denominated Parr, whose economy, prior to the enunciation of his discoveries, was involved in obscurity, and was the cause of much perplexity and hypothetical reasoning among British ichthyologists. By a series of well-conceived and skilfully conducted experiments he has not only proved that the Parr is neither a hybrid nor a species *sui generis*, but has clearly established the interesting and important truth that it is the young of the Salmon.

Residing in the immediate vicinity of the river Conway, for some years past my attention as a naturalist and a fly-fisher has been directed to the finny inhabitants of its waters and to the Salmon in particular. In the course of my researches several remarkable facts relative to the latter species in its

earlier stages of growth have come under my observation:—1st, that young males, exhibiting all the characters of the Parr, frequently have the lobes of milt fully matured, while females of the same size have the lobes of roe in so backward a state that it is necessary to employ a magnifier to distinguish the ova; 2nd, that these males shed their milt in the ensuing autumnal and winter months; 3rd, that the males of Salmon-smolts are found to have shed their milt before they descend to the sea, though the lobes of roe in the females are then of very small dimensions; and, 4th, that Smolts may be made to assume the barred appearance of Parrs by carefully removing their silvery scales.

Perceiving that Mr. Shaw, in his 'Experimental Observations on the Development and Growth of Salmon-fry,' published in the fourteenth volume of the 'Transactions of the Royal Society of Edinburgh,' had noticed the phenomena enumerated above, independent testimony to the certainty of which may serve, however, in some measure, to corroborate the accuracy of his views, I put aside my notes in which they are recorded, and probably never would have recurred to them again had not various statements contained in Mr. Andrew Young's treatise on the 'Natural History and Habits of the Salmon,' having relation to the growth of that species, induced me once more to turn to them, under the impression that they comprised evidence in favour

of a conclusion opposed to that arrived at by the latter observer.

Mr. Young has endeavoured to determine the rate of growth of the Salmon after its first arrival in the sea, by observations made upon marked individuals.

In the months of April and May he marked a considerable number of descending Smolts by making a peculiar perforation in the caudal fin by means of small nipping-irons, and in the enusing months of June and July many of them, he asserts, were recaptured ascending the river as Grilse, and weighing from three to eight pounds each, according to the difference in the length of their sojourn in the salt water*.

Hundreds of Grilse, each of the weight of four pounds, as nearly as they could be selected, were marked year by year, after having spawned, by inserting rings of copper wire into their fins, the subjects of each year's experiment being marked in a different fin; and on their second return from the sea as Salmon, in the following spring and summer,

* Mr. Young affirms that a Salmon-smolt measuring five inches in length, and weighing half an ounce, in the course of a sojourn of two months in the sea may grow into a beautiful Grilse weighing six pounds, having increased in weight one hundred and ninety-two fold in that short period. I have reason to believe that many Smolts on their descent to the sea remain in the salt water for more than twelve months.

they were observed to vary in weight from nine to fourteen pounds.

It was found also, by marking numbers of Salmon after they had spawned a second and third time, that the period of their sojourn in the sea exactly corresponds with the period required to transform Smolts into Grilse and foul Grilse into Salmon, and that the average time from Smolts descending the rivers in which they are bred to the sea until they return as Grilse, and from Grilse leaving the rivers in which they have spawned until they return as Salmon, is about eight weeks.

A Salmon which had spawned, weighing ten pounds, Mr. Young informs us, was taken by His Grace the Duke of Athole in the Tay, near Dunkeld, on the 31st of March, 1845, and was returned to the river after having been marked with a zinc ticket numbered 129. In the short space of five weeks and three days this fish, with the ticket attached to it, was caught returning from the sea, and then weighed twenty-one pounds and a quarter. This instance, Mr. Young remarks, ranks among the earliest returns of the Salmon to fresh water that have come to his knowledge, and also presents the most interesting and remarkable example of the rapid increase of weight in this species with which he is acquainted; but how this statement and the results of preceding experiments can be reconciled with the assertion made in another place—namely,

that Grilse on their first arrival in rivers are small in size and long for their weight, some of them weighing only a *pound* and others *less*—I am at a loss to conjecture.

Such are the principal experiments on the growth of the Salmon detailed in Mr. Young's treatise; and the inference deduced from them is, that in its transition from a Smolt to a Grilse, from a Grilse to the perfect state as to form and aspect, and also in the perfect state, the rate of growth is extraordinarily rapid during those portions of its existence which are passed in the sea, but that Salmon do not increase in weight while they remain in fresh water.

Now, though it is an undoubted fact that great deterioration in the *condition* and, consequently, in the *weight* of Salmon uniformly takes place while they are engaged in perpetuating their species, yet that the growth of young individuals which do not accompany their congeners to the sea is steadily progressive, observation and experiment plainly show. Salmon-fry from 7 to 8 inches long, having all the characters of the Parr, may be taken in the Conway and its tributary streams in small numbers late in the month of June, after the Smolts of the season have quitted those rivers; and occasionally I have obtained specimens of still larger dimensions, weighing four ounces. The physical cause, whatever it may be, which prevents

these fish from acquiring the migratory dress and instinct of their species, evidently does not prevent them from increasing in growth and improving in condition, even the males which have shed their milt presenting every appearance of renovated health and vigour.

Mr. Yarrell, in his 'History of British Fishes,' vol. ii. p. 21, states that a large landed proprietor in Scotland, in April 1831, put a dozen or two of small Salmon-fry, three or four inches long, into a newly formed pond between three and four acres in extent. No fishing was allowed in this pond till the summer of 1833, when several of these Salmon were taken, weighing from two to three pounds, perfectly well-shaped, well-coloured, and well-flavoured. As these fish must have been in their second year when put into the pond, it follows that they attained to the weight of two or three pounds in rather more than three years.

In the Supplement to the second volume of Mr. Yarrell's work other examples of the growth of young Salmon in fresh water are given (pp. 5 & 6), from which it appears that in one instance there was an increase in weight of eleven or twelve ounces in sixteen months, and in another instance an increase of fourteen or fifteen ounces in twenty-seven months.

I shall now proceed to inquire into the growth of the Salmon during its sojourn in the sea.

Early in the month of June, Salmon in high condition, weighing three pounds and upwards, ascend the Conway in considerable numbers if the state of the water be favourable; but that they cannot be identical with the Smolts of the same year is manifest, because the inversion of established physiological principles is involved in the opposite supposition; for as great numbers of young Salmon weighing from half a pound to a pound come up the same river in August, full two months later than the former, there is no escaping from the unphilosophical conclusion to which such an hypothesis leads—namely, that young Salmon decrease in size as they increase in age. To avoid the awkwardness of this dilemma, it is only necessary to admit the identity of the small Salmon which ascend the Conway in August with Smolts of the preceding spring; and this view of the subject (which, if correct, completely subverts the theory of the all but preternatural growth of the Salmon in salt water) derives support from the gradual increase of this species in size when restricted to fresh water, and from some circumstances attending the loss of its teeth from the vomer.

Adult Salmon of average dimensions are known to have one or two teeth only at the anterior extremity of the vomer, though Smolts have the same part amply provided with teeth extending along a great portion of its length. In the summer of 1840 I examined numerous specimens of Salmon in vari-

ous stages of growth, for the purpose of ascertaining the period at which the teeth begin to disappear from the vomer and the order in which they are shed. Specimens weighing from two to five pounds, taken in the months of June and July, had from three to seven teeth on the anterior part of the vomer, the number, allowing for the difference in condition, being almost always inversely as the weight; and individuals of a larger size, captured at the same time, usually retained one or two teeth only, situated quite at its anterior extremity. Other specimens, weighing from half a pound to a pound, taken in the month of August, were found to have the vomer well supplied with teeth, except at its posterior part, from which some had been lost invariably. The situation which the lost teeth have occupied is distinctly marked by dark spots in small Salmon, but as they increase in size these spots become more obscure and ultimately are obliterated.

As the teeth disappear from the vomer gradually and nearly in regular succession, those at the posterior part being shed first, it follows that the youngest fish, generally speaking, will have lost the fewest; consequently, the small Salmon which ascend the Conway in August may be safely regarded as identical with the Smolts which descended the same river in the preceding spring.

Having attempted to show that the growth of the Salmon during its first visit to the sea is not so rapid

as has been supposed, I may state that I see no reason for believing that it is accelerated in an extraordinary degree at any subsequent period of its life. The Salmon which come up the Conway annually exhibit every gradation in weight from half a pound, or under, to thirty-five and forty pounds. This would hardly be the case were the belief in their extremely rapid growth well founded, neither would individuals of large dimensions bear so very small a numerical proportion as they are known to do to those of a medium size.

In pursuing researches of this description it is desirable that measurement should be attended to as well as weight, for Salmon of the same weight precisely often differ remarkably in their dimensions according to the *condition* they are in; and the neglect of this circumstance, I am inclined to think, has contributed greatly to encumber the question with difficulties. That *condition*, considered with reference to weight, must have exercised no small share of influence in the case of the Grilse weighing four pounds marked by Mr. Young after they had spawned, and recaptured in the ensuing spring and summer as Salmon weighing from nine to fourteen pounds, and in that of the Salmon weighing ten pounds taken by the Duke of Athole after it had spawned, and retaken thirty-eight days afterwards, when it weighed twenty-one pounds and a quarter, cannot be doubted.

For the following Table of the dimensions and weight of Salmon differing in condition I am indebted to my brother, Mr. Thomas Blackwall.

Length, in inches.	Girth, in inches.	Weight, in pounds.
23	13	5
26	12	5
28	..	5
26	13	7
29	14	7
29	15	$8\frac{1}{2}$
31	15	9
28	18	$11\frac{1}{2}$
33	$15\frac{1}{2}$	$11\frac{1}{2}$
35	$17\frac{1}{2}$	$15\frac{1}{2}$
34	18	16
36	$19\frac{1}{2}$	$18\frac{1}{2}$
39	$18\frac{1}{2}$	$18\frac{1}{2}$
36	20	20
42	18	21
39	$20\frac{1}{2}$	23
34	13	—

The Salmon which ascend the Conway are frequently infested internally by the *Lepeophtheirus Strömii* of Dr. Baird's 'Natural History of the British Entomostraca,' and internally by Entozoa, three perfectly distinct species being sometimes found in the intestines of the same individual. These internal parasites abound in Salmon newly arrived in the fresh water; but in various specimens which I have exa-

mined in March, when they had spawned and were about to return to the sea, scarcely any were to be seen. My observations, however, are too limited to warrant the deduction of any general conclusions in relation to this curious subject, which certainly merits further investigation.

Researches relative to the growth of the Salmon and also to the economy and growth of the Sewin, or Bull-trout, conducted on the foregoing plan, have been continued as suitable occasions presented themselves; and I am induced to insist upon the decided advantage which a recourse to physiological phenomena possesses in investigations of this kind over the customary practice of mechanically marking fish as objects of experiment, in consequence of the various sources of error to which the latter mode of proceeding is exposed.

Persons, in their endeavours to determine the rate of growth in fish by marking specimens, too frequently employ subordinate agents to carry their intentions into effect, to whom not only their system of marks is of necessity made known, but the anticipated result is also communicated. Now, should it so happen that the agents are dependent upon their employers, or in any respect interested in making the event appear to coincide with their preconceived opinions, the desired object may be easily attained either by secretly marking specimens of a larger size than those which they were instructed and perhaps

observed to select for the purpose, and by exhibiting them alone when recaptured, or by adapting the marks to fish subsequently taken, whose dimensions appear to be best suited to promote the end they have in view. Besides, it often happens that all the particulars of the undertaking transpire, and, becoming widely circulated, other parties resident in the neighbourhood may apply similar marks to fish of different sizes captured in the same stream, more especially to kelts, which are comparatively of little value; and that this is not merely a supposititious case, or an imaginary cause of delusion, I can confidently affirm from personal experience. Perforations, and the total or partial excision of any of the fins, may be objected to on account of the modifications which such marks undergo with the growth of the fish, and also on account of the mutilations to which those members are liable from incidental circumstances.

Having thus succinctly directed attention to a few of the objections which may be urged against the manner in which attempts to ascertain the rate of growth in fish by employing artificial marks are generally conducted, I shall revert to the method pursued in my own researches—namely, careful and frequently repeated observations on the gradual loss of the teeth from the vomer, on the order in which they are shed, and on the changes known to take place in the figure of the caudal fin.

The usual number of teeth on the tongue of the

Salmon-smolt and Sewin-smolt of six or seven inches in length, when none has been lost, is ten, arranged in a row of five on each side; occasionally I have counted as many as twelve in both species, but ten appears to be the normal number. These teeth are not shed, but most of them are torn away by violence in an irregular manner as the fish advance in growth, so that a want of symmetry in the two rows is conspicuous in much the greater number of individuals. I may remark that such is the case also in every particular with the teeth on the tongue of the Common Trout (*Salmo fario*), and that the teeth on the vomer of this species are not shed, but, like those on the tongue and jaws, some of them are frequently removed in an irregular manner by violence.

The teeth on the vomer of the Salmon-smolt and Sewin-smolt commonly exceed twenty (in numerous instances I have noticed twenty-four)—a fact which the minute inspection of the heads of both species, after having been placed in nests of the Great Wood-Ant (*Formica rufa*), and subjected to the anatomical process so admirably effected by that industrious insect, fully confirms. Unlike the teeth on the tongue, those on the vomer are shed gradually, commencing at the posterior part and disappearing in nearly regular succession as the fish increase in size; consequently the loss of teeth from the vomer, taken in conjunction with the form of the tail and the growth of these species, affords to experienced observers a

sufficiently exact criterion for determining their relative ages within certain limits.

Smolts of the Salmon and Sewin have the caudal fin much forked; but a progressive alteration in the shape of this organ is effected by the more rapid elongation of its central rays as the fish advance in growth, till, on the acquirement of its perfect development, the posterior margin becomes nearly straight in the Salmon, and actually somewhat curved outwards in large males of the Sewin, thus supplying the means of forming a comparative estimate of the ages of both species.

In accordance with what is here stated, I find that specimens weighing from half a pound to a pound and a half have the caudal fin more or less forked and the vomer well supplied with teeth except at its posterior part, from which some are lost invariably. Specimens weighing from two to five pounds have the posterior margin of the caudal fin either moderately forked or nearly straight, according to their size, and usually have from three to seven or eight teeth on the anterior part of the vomer, the number, after making a suitable allowance for differences in condition, being almost always inversely as the weight; and individuals of large dimensions constantly have the posterior margin of the caudal fin nearly straight or slightly curved outwards in males of the Sewin, and retain one or two teeth only at the anterior extremity of the vomer, or are even without any.

Young Salmon and Sewin weighing from about half a pound to a pound ascend the river Conway during the month of August in much greater numbers than at any other period of the year; and as many of them are infested with the marine parasite *Lepeophtheirus Strömii*, in various stages of growth, there can be no doubt that they have very recently quitted the salt water. These fish, which from oft-repeated examinations of numerous individuals are found to have the tail forked in a greater or less degree, and uniformly to have lost some teeth from the posterior part of the vomer, though its anterior part is still amply provided with them, I feel thoroughly convinced are identical with Smolts of both species which descended the same river in the preceding spring, having then the full complement of teeth on the vomer; for Salmon and Sewin of smaller dimensions do not at any time come up the Conway from the sea, as may be ascertained by actual inspection in calm bright weather, when the water is low and clear and the shoals of fish can be distinctly seen; and if further proof be required, it is abundantly supplied by the conclusive evidence obtained from the large number of specimens taken annually. It is true that I have occasionally procured Salmon and Sewin in the months of March and April which have weighed six ounces only; but they have always been males which had milted or females which had deposited their ova and were out of condition, or what in Scotland are denominated kelts.

I shall here introduce to notice a few examples illustrative of the loss in weight which Salmon and Sewin undergo by the act of spawning.

On the 12th of November, 1844, a Salmon was captured weighing fifteen pounds, the weight of the lobes of roe, which contained a large quantity of ova in an advanced state of development, being two pounds and three quarters.

A Salmon captured on the 13th of November, 1844, weighed seven pounds and a half, and the weight of the lobes of roe, which comprised ova almost in a fit state to be deposited, was two pounds.

A Sewin taken on the 18th of November, 1844, weighed five pounds and a half, the weight of the lobes of roe, which contained ova in an advanced state of development, being one pound and a quarter.

On the 11th of October, 1847, a Sewin weighing half a pound was captured, whose lobes of roe, comprising ova nearly ready for deposition, weighed two ounces.

A Salmon weighing fifteen pounds and a half was taken on the 22nd of October, 1847, and the lobes of roe, which contained ova in an advanced state of development, weighed three pounds.

The lobes of roe, comprising highly developed ova, taken from a Salmon weighing twenty pounds, which was captured on the 10th of November, 1847, weighed three pounds and fourteen ounces.

Took the lobes of roe, containing ova on the point of being deposited, from a Salmon weighing sixteen pounds, which was captured on the 26th of November, 1847, and found their weight to be four pounds.

From these instances it is apparent that the weight of Salmon and Sewin may be diminished one fourth by the emission of their ova alone, the weight of the collapsed ovaries with their included germs being too insignificant to be taken into consideration; and if to this cause of decreased ponderosity be added another, namely, deterioration in condition during the sojourn of these species in fresh water, the absolute loss in weight may be estimated at one third or more—a circumstance which ought on no account to be overlooked in attempts to determine their rate of growth by marking individuals; and this remark applies with peculiar force when the subjects selected for experiment are kelts, as, unfortunately, it is too commonly the practice to omit measurement altogether on such occasions, and merely to give a statement of weight, which, unaccompanied by other data, is evidently insufficient to decide the point in question.

It appears then, from the physiological facts detailed above, that the growth of Salmon and Sewin during their first visit to the sea is much less rapid than it is commonly supposed to be; and as in the shoals of these species, which are more abundant in the Conway than any of the other migratory Salmo-

nidæ, fish may be observed presenting every gradation of size from the least to the greatest, it is reasonable to infer that their rate of growth is not accelerated materially at any subsequent period of their existence, especially as individuals of large dimensions are found to be very disproportionate numerically to those of a small or even of an average size.

By the cautious inspection of Salmon and Sewin in one of the tributaries of the Conway running through my father's land, up which, when swollen with rain in the months of October and November, they ascend for the purpose of depositing their spawn, and by the frequent examination of their progeny in different seasons of the year, I have satisfied myself that in their economy as well as in their rate of growth these species bear a close resemblance to each other. Both remain in large numbers for two years in the fresh water after their extrication from the ovum, during which period, notwithstanding the result of the conclusive experiments so skilfully conducted by Mr. Shaw, of Drumlanrig, they are still indiscriminately named Parr in this district*, and do not descend to the sea till they have acquired their migratory dress or have been converted into Smolts, when they usually measure from five to seven inches in length, and weigh from half an ounce to an ounce and a half. I have

* A Sewin in its second year more nearly resembles a Trout than a Salmon of the same age.

ascertained also, by the dissection of very numerous specimens, that the males of the Salmon and Sewin shed their milt before they make their first descent to the sea, but that the females do not spawn till they return from their first visit to the salt water; indeed the ova are so little developed in the month of May, at which time the principal migration seaward takes place, as scarcely to be discerned without the aid of a magnifier.

Perhaps no appellation employed by ichthyologists to designate any of the various stages of growth through which the Salmon passes has been more abused or has led to greater confusion and misapprehension than the Scotch term Grilse, which is applied to fish of this species supposed to have returned from the sea for the first time and not to have spawned; but as male Salmon-smolts are known to have milted before they descend to the sea, it is plain from this fact, independently of others, that the term ought to be rejected.

Among the external characters which serve to distinguish the Sewin-smolt from the Salmon-smolt are:—a more robust and trout-like figure, a more decided prominence of the row of scales forming the lateral line, a greater number of spots below that line, a yellowish tinge on the lighter-coloured pectoral fins, a bright-red tint at the extremity of the adipose fin, and a firmer adhesion of the scales to the skin.

In conclusion, I shall briefly notice a few cases of

rapid changes in the colour of fish which have come under my own observation. Trout suddenly transferred from their natural haunts into wooden, metallic, or earthenware vessels supplied with water recently taken from the same stream in which they were captured speedily assume a lighter hue; and as this change does not appear wholly to depend upon the colour or capacity of the vessels in which they are placed, I am inclined to attribute it primarily to the influence of fear; and in this opinion I am the more confirmed from having frequently perceived a similar transition in the hue of Salmon soon after they have been hooked by the angler. That this is not the sole occasion of sudden alterations in the colour of fish I readily admit; for I have often disturbed small Flounders in the Conway, which, on changing their situation and reposing upon objects of a different hue from those they had last quitted, soon became accommodated to this circumstance of their novel position by undergoing a modification of tint which harmonized with that of their resting-place and effectually served to conceal them from ordinary observation. Even death, as the disciples of Isaac Walton are well aware, and as the following anecdote clearly proves, does not immediately put a stop to this chameleon-like transition of colour.

A gentleman of my acquaintance, a proficient in the art of fly-fishing, had taken a young Salmon weighing about a pound and a half, which, in conse-

quence of having been a long time in the fresh water, had lost its brilliancy, and had acquired a very dark aspect. This fish one of my children requested to be permitted to carry; so, after having inserted the longer and smaller end of a slender forked twig under one of the gill-covers and drawn it through the mouth till the prize was retained in the angle formed by the fork, I gave it to the boy, who held it suspended with the tail downwards. After a lapse of several minutes, perceiving that the fish had lost all its blackness and had become perfectly bright, I directed the attention of my acquaintance to it, who could scarcely be persuaded that it was the same which he had captured a short time before, but supposed that I had secretly substituted another for it; however, the speedy resumption of its former dark complexion, which underwent no further mutation, completely convinced him of its identity.

I shall not attempt to offer any explanation of the remarkable physiological phenomenon here recorded; but, apart from the mysterious operation of psychological agency, its cause must undoubtedly be sought for in the organization of the integuments.

A

REMARKABLE PHYSIOLOGICAL FACT.

A Spaniel bitch, belonging to Mr. Robert Scholes, of Cheetham Hill, near Manchester, in the autumn of the year 1830, brought up a kitten and a fawn of the Fallow Deer, which she attended to as assiduously as if they had been her own offspring. Instances of animals, when deprived of their young, attaching themselves to the progeny of other species, endowed with physical and mental powers differing widely from their own, are of frequent occurrence; and the warmth of affection usually manifested towards the nurslings on such occasions proves how deeply the parental feelings are implanted in the inferior orders of animated beings. I have known the Domestic Cat, for example, take charge of young Squirrels and young Hares, which, but for the powerful influence of this active principle, would, in all probability, have fallen victims to feline voracity. But what renders the case before us peculiarly interesting to the physiologist is the fact that the bitch, which was only about fourteen months old, had never

had whelps; it is reasonable to suppose, therefore, that the secretion of milk in her teats was promoted by the excitation induced by the repeated efforts of the kitten and fawn to derive sustenance from that source. The fawn increased in growth so rapidly that it soon greatly exceeded its foster-mother in stature.

ON THE

INJURY DONE TO THE FOLIAGE OF THE OAKS

IN THE NEIGHBOURHOOD OF MANCHESTER IN THE SPRING OF 1827.

INSECTS, though diminutive in size and insignificant in appearance, when associated together in large numbers frequently become exceedingly formidable and destructive. A striking illustration of this fact is supplied by the appalling devastation which is sometimes occasioned by extensive bodies of Locusts, a circumstance thus emphatically described in the bold figurative language of the prophet Joel, ii. 2–6 :— "A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning spread upon the mountains: a great people and a strong; there hath not been ever the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them; and behind them a flame burneth: the land is as the garden of

Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. The appearance of them is as the appearance of horses; and as horsemen so shall they run. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their face the people shall be much pained: all faces shall gather blackness." From this dreadful scourge, and from other plagues of a similar though less distressing character, the inhabitants of the British Isles are, fortunately, in a great measure, exempt. Still they do, occasionally, experience much inconvenience, both as regards their persons and property, from noxious animals of this class. A multitude of examples confirming the truth of this remark might easily be adduced; but as lengthy details, relative to a matter of such general notoriety, would, in all probability, be deemed superfluous, I shall, in the present instance, limit my observations to a single case, in which the oaks in the vicinity of Manchester were nearly stripped of their foliage by two minute species of insects.

Early in May, 1827, the Green Weevil (*Curculio argentatus*) appeared in unusual numbers in this neighbourhood, and by its extensive ravages greatly disfigured many of our most ornamental trees and shrubs; the copper-beech in particular, in some situations, suffered severely. Towards the termina-

tion of the month this indiscriminate feeder attacked the young leaves of the oak, which were then expanding, and the effects of its depredations soon became very conspicuous in the gnawed and withered foliage.

To this pest quickly succeeded another, the larva of a small moth, *Tortrix viridana*, which completed the devastation commenced by the Green Weevil; and the monarch of the grove, nearly destitute of verdure and loathsome with numerous caterpillars, stood almost leafless, wearing a wintry aspect even in the middle of June. These caterpillars, in common with many others provided with an apparatus for spinning, on being disturbed, hastily quit their retreats among the convoluted leaves, and descend towards the earth by a fine line, formed of a viscous secretion, which hardens on exposure to the atmosphere. So extremely abundant were they at the period alluded to, that during a brisk wind thousands might be seen thus suspended—some carried out by the breeze far beyond the widest-spreading branches of the tree to which their threads were attached, others, with violent contortions, slowly ascending their silken filaments, and all, as they were wafted to and fro, fantastically dancing in the agitated air without any visible support, their lines being too attenuated to be discerned by the unassisted eye, except when they occasionally reflected, with a silvery lustre, the vivid light of the un-

clouded sun. The spectacle, as may be supposed, was at once highly singular and interesting.

During the continuation of these insects in the larva state, various species of the feathered tribes feasted upon them luxuriously. The Wood-Wren, Yellow Wren, Whitethroat, and, indeed, the Warblers generally were among the most vigilant and destructive of their enemies, and must have reduced their numbers greatly. The Finches also, particularly the Chaffinch and House-Sparrow, were indefatigable in quest of them; and even the Domestic Poultry sought with avidity for those which, by design or accident, descended to the ground.

In the month of June they underwent their second change, or were converted into chrysalides; and in this almost inactive stage of existence, in which several of the animal functions are suspended and others are only imperfectly exercised, they displayed an instinct deserving particular notice. Concealed within the cavities which they had formed when caterpillars, by folding down the edges of the leaves and securing them in that position with a little of the glutinous secretion discharged by the spinning-apparatus, they awaited their final transformation; but, as if aware that so confined a situation would present too many obstacles for a delicate and newly disclosed moth to overcome, without incurring a great risk of sustaining injury at the important crisis, they made their way to the mouths of their retreats, and pro-

truding themselves as far as they could consistently with security, their exterior covering ultimately gave way, and in July the insects made their appearance in the imago or perfect state.

Having procured some of the larvæ of this moth, for the purpose of observing the metamorphoses they undergo and identifying their species, I put them into clean phials of transparent glass, the perpendicular sides of which they readily ascended by means of lines of their own spinning, after the manner of the caterpillar of the Goat Moth*. This circumstance induced me to try the experiment with the larvæ of other insects. Capturing, indiscriminately, such as came in my way, I soon collected a considerable number; and, on introducing them into the phials, found that several of them made their way up the glass without any apparent difficulty, while others were totally incapable of doing so. These ascents, in many instances, were effected by spinning lines, which were made to answer the purpose of a ladder, as noticed above, in some by the assistance of a slimy or viscid secretion which left a sensible trace on the glass, and in others by a method which I cannot satisfactorily explain, the caterpillars, in this case, neither spinning lines nor leaving any perceptible trace behind them. At first I was disposed to

* Mr. Curtis, in his 'British Entomology,' vol. ii. plate 60, has given an excellent figure of this caterpillar, representing it in the act of climbing.

think that their spurious legs, or prolegs (*propedes*), as they are denominated by Messrs. Kirby and Spence, in their 'Introduction to Entomology,' acted as suckers, and that they were held to the sides of the phials by atmospherical pressure. It soon occurred to me that the accuracy or inaccuracy of this supposition might be ascertained by means of the air-pump. Under this impression I applied to Dr. Dalton, who was so obliging as to allow me the use of his instrument, and to lend me his assistance in conducting the experiment. The result, however, proved the reverse of what I had anticipated; for, notwithstanding the pressure was very greatly reduced, the caterpillars were still capable of ascending the phial in which they were enclosed: it is probable, therefore, that some adhesive matter, which, perhaps, is not liable to leave a sensible stain upon glass, may be secreted in small quantities by the spurious legs of these larvæ, and that they are thus, in opposition to the attraction of gravitation, enabled to climb up the vertical sides of bodies with smooth and even highly polished surfaces *. A minute examination of the structure of the false legs, under a powerful microscope, might possibly throw some light on this curious subject, which, it must be acknowledged, merits further investigation.

* The near approximation of this conjecture to the truth will be rendered apparent when the means by which certain animals ascend the vertical surfaces of highly polished bodies are treated upon.

The injury sustained by the oaks on this occasion was not limited to those which grow in this particular district. I am well informed that in other parts of the county, and in Yorkshire, Cheshire, Derbyshire, Shropshire, Middlesex, &c., many were similarly affected; and it is probable that the mischief extended much further. The damage done to the first leaves was, in a considerable degree, repaired by the development of a second set about the close of June and the beginning of July, the lively tints of which gave to our oak-woods, at that season of the year, the appearance of spring; but the bloom, as well as the early foliage, having been nearly destroyed, the crop of acorns, which had promised to be unusually abundant, proved remarkably defective.

Various were the opinions entertained as to the cause of this blight, as it was generally termed, it being severally ascribed to disease, to lightning, to the cold winds which prevailed in the spring of the year, and to the ravages of insects. The last conjecture happens to be correct; but few persons gave themselves the trouble to establish its accuracy by actual observation, and still fewer endeavoured to determine the species of those depredators. Their vast multitudes may, with much plausibility, be attributed to the high temperature of the preceding year (1826) having been extremely favourable to their increase; for in the same season many other insects were also very numerous, especially the various

species of *Aphis* and their natural destroyers the *Coccinellæ*. Among the latter, *C. 7-punctata, C. 4-pustulata*, and *C. 2-punctata* greatly predominated. The last two are considered to be distinct, and, accordingly, have had different specific names assigned to them by entomological writers; but that excellent botanist and attentive observer of the economy of insects, the late Mr. Edward Hobson, of Manchester, assured me that they are opposite sexes of the same species, *C. 2-punctata* being the male and *C. 4-pustulata* the female. Some observations of my own, made since I have been in possession of Mr. Hobson's communication, had disposed me to regard *C. 4-pustulata* as the male and *C. 2-punctata* as the female; but I am now convinced that the colours of the sexes are liable to vary.

Through the kindness of my friend Mr. Peter Barrow, I have been favoured with a sight of the fifty-second number of Mr. Curtis's work on 'British Entomology,' which has been published since the above remarks were written. In treating upon *Coccinella ocellata*, the author observes that the genus *Coccinella* "is at once a remarkable example of the value of structure in the combination of groups, and of the little importance of the distribution of colour when employed to distinguish species. As a genus, *Coccinella* is so natural that its appellation has never been disturbed; whereas the species composing it

are so variable that many of them have been described under a great variety of names." Mr. Curtis, without alluding to sexual distinctions, brings together the following synonyms under the specific name *dispar* :—"*pantherina* and *annulata*, Linn., Don. 7. 243. 2; *bipunctata* and 6-*pustulata*, Linn., Don. 2. 39. 3; *unifascia* and 4-*pustulata*, Fab., Don. 7. 243. 3; *perforata* and 7-*pustulata*, Mar.; 4-*punctata*, Don. 16. 542." Subsequent researches induced Mr. Hobson to coincide with me in the opinion that the distribution of colour affords no criterion which will serve to distinguish the sexes of *C. dispar*.

ON

THE MEANS BY WHICH VARIOUS ANIMALS ADHERE TO THE VERTICAL SURFACES OF HIGHLY POLISHED BODIES.

IN the 'Physico-Theology' of Dr. Derham, p. 363, note b, it is stated that "diverse flies and other insects, besides their sharp-hooked nails, have also skinny palms to their feet, to enable them to stick on glass and other smooth bodies by means of the pressure of the atmosphere." This opinion, which appears to be adopted by some entomologists of the present day, has derived additional weight from the investigations of Sir Everard Home, whose papers relative to this curious subject, illustrated by figures of the parts employed in climbing, engraved principally from drawings made by Mr. Bauer, are published in the 'Transactions of the Royal Society' for 1816. These researches are regarded by Messrs. Kirby and Spence (see their 'Introduction to Entomology,' vol. ii. letter xxiii.) as having "proved most satisfactorily that it is by producing a vacuum between certain organs destined for that purpose and the plane of position, sufficient to cause atmospheric

pressure upon the exterior surface, that the animals in question are enabled to walk up a polished perpendicular, like the glass in our windows, or with their backs downward on a ceiling, without being brought to the ground by the weight of their bodies." To dissent from an hypothesis so generally received, including among its advocates numerous illustrious names, may, perhaps, be deemed presumptuous; nevertheless, as facts absolutely irreconcilable with this supposition have been forced upon my attention, while engaged in examining the evidence by which it is supported, I shall, with every sentiment of respect for the high authorities to whom I stand opposed, submit my views to the consideration of candid and intelligent naturalists.

Concerning the structure of the instruments by means of which flies ascend the vertical sides of smooth bodies, various opinions have been promulgated. Some authors compare them to sponges, and conjecture that they are designed to contain a glutinous secretion capable of adhering to well-cleaned glass. Dr. Hooke describes them as palms or soles beset underneath with small bristles or tenters, like the wire teeth of a card for working wool, which he conceived give them a strong hold upon objects having irregular or yielding surfaces; and he imagined that there is upon glass a kind of smoky substance penetrable by the points of these bristles*.

* 'Micrographia,' pp. 170, 171.

According to the observations of Sir Everard Home, they are expanded membranes, having their inferior surface granulated and their edges beautifully serrated *; while Messrs. Kirby and Spence, on the contrary, remark that they are downy on the underside and granulated above †.

The want of accordance so conspicuous in the preceding accounts induced me to inspect the parts minutely under a good compound microscope, when it was immediately perceived that the function ascribed to them by Dr. Derham and Sir E. Home is quite incompatible with their organization. Minute hair-like papillæ, very closely set and directed downwards, completely cover the inferior surface of the expanded membranes, improperly denominated suckers, connected with the terminal joint of the tarsi of flies, the edges of which are plain, not serrated, as Sir E. Home asserts, though, when placed in such a situation relative to the eye of the observer that the hair-like papillæ in connexion with them are foreshortened, they certainly present an appearance which, on a superficial view, might lead to the latter conclusion. This circumstance of the underside of the tarsal membranes of flies being densely covered with erect papillæ effectually prevents its being brought into contact with the objects on which those insects move by any muscular force they are capable of exerting:

* 'Transactions of the Royal Society' for 1816, p. 323.

† 'Introduction to Entomology,' vol. ii. letter xxiii.

the production of a vacuum between each membrane and the plane of position is, therefore, clearly impracticable, unless the numerous papillæ on the underside of these organs separately perform the office of suckers; and there does not appear to be any thing in their mechanism which in the slightest degree countenances such an hypothesis. When highly magnified, their extremities, it is true, are seen to be somewhat enlarged; but whether they be viewed in action or in repose, they never assume a figure at all adapted to the formation of a vacuum.

Satisfied that this difficult problem must admit of a solution more consistent with the various phenomena it comprehends than the popular one here controverted, I determined to institute an experimental investigation of it. Accordingly, having procured living specimens of the House-fly (*Musca domestica*) and of the large Flesh-fly (*Musca vomitoria*), I enclosed them in clean jars and phials of transparent glass, the interior surface of which they traversed in every direction with the greatest facility, walking upon it, even with their backs downward, while they remained in full vigour; but when enfeebled by exposure to cold, or by over-exertion, the identical individuals ascended the sides of the same jars and phials with considerable difficulty, falling from them in numerous instances, and they were entirely incapacitated for adhering to them in an inverted position; yet when their physical energy was restored by re-

pose or an increase of temperature, they again repeated their most extraordinary feats with all their original promptness and dexterity.

Flies which are unable to maintain an inverted position on highly polished bodies will frequently adhere firmly, with their backs downward, to glass rather defective in polish or slightly soiled; indeed I may remark generally that the results of experiments similar to those detailed above will always be modified by the vigour of the insects and the state of the glass vessels with regard to cleanness and polish.

These facts plainly indicate that flies are not supported on the vertical sides of smooth bodies by the pressure of the atmosphere; and the only link in the chain of evidence which was wanting to place the matter beyond all dispute, the kindness of Mr. W. Hadfield, of Cornbrook, has enabled me to supply. With his assistance and the help of his air-pump it was proved, to the entire satisfaction of several intelligent gentlemen present, that the House-fly, while it retains its vital powers unimpaired, can not only traverse the upright sides, but even the interior of the dome of the exhausted receiver; and that the cause of its relaxing its hold, and ultimately falling from the station it occupies, is a diminution of physical energy attributable to impeded respiration. To this circumstance in particular, as furnishing an *experimentum crucis* by which the fallacy of the prevailing

hypothesis may be ascertained, I am solicitous to direct the attention of naturalists.

I am aware that the males of several aquatic beetles have the tarsi of the first and second pairs of legs supplied on the underside with numerous cup-shaped suckers of various sizes, which have their edges (the larger ones at least) beautifully fringed with delicate hairs. These suckers, which probably serve to facilitate the intercourse of the sexes, are remarkably conspicuous on the tarsi of the males of a very common species, *Dyticus marginalis*, and unquestionably give them a firm hold of smooth objects occurring in water, a liquid whose specific gravity rather exceeds their own; but that they are inadequate to the support of this insect, the average weight of which is about twenty-eight grains, on the vertical sides of dry polished bodies, in so rare a medium as air, I have had frequent opportunities of remarking. My chief object in adverting to these singular organs, on the present occasion, is to guard entomologists against the error of supposing that they correspond to the pulvilli of insects, which, as I have attempted to show, differ from them essentially both in structure and function.

Having demonstrated the insufficiency of the received explanation of the movements of flies on polished perpendicular surfaces, I shall now endeavour to establish a more satisfactory one in its place.

In pursuing my experiments with the House-fly I

observed that individuals sometimes remained fixed to the sides of an exhausted glass receiver after they had entirely lost the power of locomotion, and an evident distention of the abdomen had been occasioned by the expansion of the aëriform fluids it contained. To detach them from those stations the employment of a small degree of force was found requisite. This occurrence, which first suggested to me the true cause of the phenomena under consideration, induced me to prosecute the inquiry more extensively than I had hitherto done. Selecting clean phials of transparent glass, I placed in them spiders and various insects in the larva and imago states, capable of walking on their upright sides. I then breathed into the phials till the aqueous vapour expelled from the lungs was copiously condensed on their inner surface. The result was remarkable. The moisture totally prevented those animals from obtaining any effectual hold on the glass; and the event was equally decisive if a small quantity of oil was substituted for the aqueous vapour. A similar consequence ensued also when the flour of wheat, or finely pulverized chalk or gypsum, was thinly distributed over the interior surface of the phials, the minute particles of those substances adhering to the tarsal brushes of the spiders, the pulvilli of the perfect insects, and the underside of the feet of the larvæ. These facts appeared quite inexplicable, except on the supposition that an adhesive secretion is emitted by

the instruments employed in climbing. The next point to be determined, therefore, was, whether spiders and insects in the larva and imago states, when moving in a vertical direction on clean glass, leave any visible track behind them or not. Careful and repeated examinations, made with lenses of moderately high magnifying-powers, in a strong light and at a favourable angle, speedily convinced me that my conjecture was well founded, as I never failed to discover unequivocal evidence of its truth; though, in the case of the spiders, considerable difficulties presented themselves in consequence of the exceedingly minute quantity of adhesive matter emitted by the brushes of those animals. On submitting this secretion to the direct rays of the sun in the month of July, and to brisk currents of air whose drying power was great, I ascertained that it did not suffer any perceptible diminution by evaporation under those circumstances.

Now it is reasonable to infer from the foregoing researches that the hair-like appendages constituting the brushes of spiders, and occurring in such profusion on the inferior surface of the pulvilli of insects, are tubular. The delicate membrane also on the underside of the prolegs, and the tarsi of the perfect legs of various larvæ capable of traversing polished perpendicular bodies without the aid of lines produced by a spinning-apparatus, must be provided with numerous pores or minute papillæ, from which

an adhesive secretion is emitted. Some larvæ which are not supplied with prolegs (those of the *Coccinellæ*, for example) have the inferior part of the tarsi of their perfect legs thickly covered with hair-like appendages, resembling in figure, and in the function they perform, those on the pulvilli of insects in the imago state; while others, altogether destitute of legs, emit a viscid mucus from both their extremities, and by advancing and attaching each alternately are thus enabled to ascend smooth bodies with facility.

The larvæ of the *Chrysomelæ*, *Coccinellæ*, and some other insects can protrude through an orifice at the extremity of the caudal or terminal segment of the abdomen a bundle of papillæ, which, by a copious emission of mucus, gives them so secure an attachment to the objects on which they move, as readily to sustain their entire weight; by assisting them occasionally in the act of progression it is also made to serve the purpose of an additional leg. Provided with a similar apparatus, the larva of the Glowworm (*Lampyris noctiluca*), though unable to ascend a vertical surface of glass, can adhere to one firmly by the application of this organ, which is composed of several branched membranous papillæ included in a common envelope. They are extremely flexible and extensile; and, either separately or collectively, can be protruded beyond the caudal segment or retracted within it at the pleasure of the animal. Their effici-

ency as a cleaning-apparatus and an organ of adhesion and progression depends, principally, upon the mucus they emit, which is secreted in great abundance, and not upon the power of producing a vacuum. When this instrument is applied to the body of the insect, any extraneous matter immediately becomes attached to it, and the impurities thus collected are ultimately expelled by a fresh discharge of mucus and a peculiar motion of the papillæ. Larvæ of the Glowworm, kept in captivity for the purpose of experiment and observation, may be fed on earthworms.

I may remark that snails, it is well known, can adhere to polished bodies by means of a mucous secretion; and from minutely inspecting preserved specimens of tree-frogs (*Hylæ*), and the lizards denominated *Geckos*, I am decidedly of opinion that those reptiles are enabled to run upon the vertical sides of smooth objects by the agency of adhesive matter emitted from pores and papillæ situated on the inferior surface of their toes.

FACTS RELATIVE TO THE MOVEMENTS OF INSECTS ON DRY, POLISHED, VERTICAL SURFACES.

As objections have been urged against the opinion that flies and other insects of various species are enabled to move on the vertical surfaces of highly polished bodies by the emission of an adhesive fluid from the numerous hair-like papillæ distributed over the inferior surface of their pulvilli, the statement of a few plain facts for the consideration of dissentients, and especially of those who still advocate the hypothesis that flies, in such instances as those referred to above, are supported in their movements mainly by the pressure of the atmosphere, may, perhaps, be deemed deserving of attention.

Without the slightest intention to undervalue the importance of microscopic researches into the organization of the parts in question, I may be permitted to remark that the careful observation of phenomena and judiciously selected and skilfully conducted experiments afford equal if not superior advantages with regard to the determination of the function they perform, and that the two methods of investigation

should be pursued contemporaneously, and, as far as opportunities will admit, in combination.

Having clearly ascertained by repeated inspections of the pulvilli of flies under the microscope, both in a state of action and repose, that a vacuum cannot possibly be formed between them and smooth surfaces to which they are applied, unless the papillæ with which they are provided separately contribute to produce such an effect, it was immediately perceived that a decisive test of the truth or fallacy of this conjecture might be obtained by means of the air-pump; and the result of its application was to demonstrate, not only that flies can traverse the upright sides and the interior surface of the dome of an exhausted receiver while their physical energy is unimpaired, but also to establish the important fact that individuals occasionally remain fixed to the sides of the glass after they have entirely lost the power of locomotion, a circumstance which admits of only one explanation, namely, that an adhesive fluid is emitted from the extremity of their papillæ. The sole suggestion hitherto advanced, which has even the appearance of at all affecting the validity of the conclusion thus arrived at, is that the specific gravity of flies is so low that a very slight degree of adhesive power is sufficient to sustain them in the position they occupy; but, low as it undoubtedly is, it greatly exceeds that of atmospheric air, and it is evident that the efficiency of the adhesive agency to support them on a polished

vertical surface *in vacuo*, thus conceded, must be ample to enable them to move on the glass of our windows in perfect security, under ordinary circumstances, without the adventitious aid of atmospheric pressure; the question of specific gravity, therefore, may be safely eliminated as being of no moment in any attempt to solve this interesting physiological problem.

The argument so much relied upon by opponents is, that if flies retained their position on polished vertical surfaces by means of an adhesive fluid emitted from the hair-like papillæ on the inferior surface of their pulvilli, they would, after remaining long in one situation, be unable to quit it by any muscular effort they could employ without seriously injuring those delicate parts, in consequence of the tenacity that the fluid would acquire by desiccation; whereas it is well known that their movements are not in the least impeded by this circumstance. Plausible as this reasoning is, it appears to be based on the erroneous supposition that the properties of the fluid resemble those of animal-glue or vegetable-gum, an assumption which is at variance with all the particulars that have been ascertained in connexion with the phenomenon; in fact the fluid merely assumes a gelatinous consistency on exposure to the atmosphere, and is readily removed from the pulvilli, when redundant, by the customary mode of cleansing those organs employed by insects, which it could not

possibly be were it of the tenacity implied by the foregoing conjecture.

That flies are unable to walk on polished vertical surfaces when breathed upon till the aqueous vapour expelled from the lungs is copiously condensed thereon is an acknowledged fact; but it does not appear to be known that when thus treated they cannot even retain the position they occupy, whether they make any visible effort to do so or not, a circumstance that seems to be quite inexplicable on the hypothesis that they are supported by the agency of atmospheric pressure, but which admits of a satisfactory explanation on the principle of a solvent fluid acting upon a gelatinous and moderately adhesive animal secretion; and these remarks apply to numerous species of insects, and also to spiders provided with scopulæ; but the latter, when they perceive their footing to be insecure, frequently attach themselves to the spot by emitting from their spinners a little of the viscid material of which their silken lines are formed, that possesses the property of being insoluble in water.

In spring, summer, and autumn House-flies may frequently be seen adhering so firmly to the upright surface of the glass of windows that they are incapable of extricating themselves though they make every exertion to accomplish that object; yet, when breathed upon till the aqueous vapour exhaled is condensed about them, they speedily fall from the spot to which

they were previously attached so strongly. Now that this remarkable affection of the House-fly cannot be caused solely by a low state of atmospheric temperature, as it has been surmised, is evident from the circumstance that it often occurs in the hottest period of the year; in the months of July and August, 1864, upwards of twenty instances of this curious fact were noticed; it must be ascribed, therefore, either to feebleness resulting from some other cause, or to an increase in the adhesiveness of the fluid secretion emitted from the papillæ in the act of climbing. If it should still be insisted upon that the phenomenon is the result of atmospheric pressure, it behoves the advocates of that hypothesis to explain in what manner a little condensed vapour causes the liberation of insects that are unable to accomplish the act by their own unaided efforts. That an organ deemed to be capable of so entirely expelling the air from the space between its extremity and smooth surfaces with which it is brought in contact as to produce a vacuum should yet be incompetent to effect the exclusion of so dense a fluid as water, does certainly appear to be in the highest degree improbable*.

* The adhesion of flies to the glass of windows and to other surfaces, towards the end of summer and in autumn, is usually caused by the growth from the interior of the body of a parasitic fungus (*Sporendonema muscæ*, Fries; *Empusa muscæ*, Cohn).

The promptness and celerity of the movements of flies in an inverted position, or with their backs downwards, on highly polished surfaces, and the certainty with which their hold is immediately secured when they alight upon them, would seem to preclude the possibility of the employment of muscular force on such occasions adequate to the instantaneous expulsion of the air between their delicate climbing-apparatus and the plain on which they move, to the extent required for the formation of an efficient vacuum; but every difficulty is at once obviated by admitting that a minute quantity of moderately adhesive fluid, which acquires a gelatinous consistency on exposure to the atmosphere, is emitted from the organs of sustentation. Unexceptionable evidence that such actually is the case has been obtained by observing that the extremity of each papilla becomes cauterized when subjected to the action of finely pulverized nitrate of silver; and that insects, when traversing a vertical surface of glass, leave upon it a visible and enduring trace of their path, for the better perception of which a lens having a high degree of magnifying-power should be employed.

Though perfectly satisfied that the conclusion deduced by me from the experiment with the air-pump rests on too secure a basis to be subverted, yet a desire to remove all apparent difficulties which may be thought to militate against the view that I have promulgated of the means by which numerous species

of insects and spiders, and even some reptiles, are enabled to move on dry, polished, vertical surfaces, must serve as my excuse for obtruding once more on the attention of naturalists a subject that has been the occasion of so much controversy.

ON AN

INSECT OF THE FAMILY *ICHNEUMONIDÆ*

WHOSE LARVA IS PARASITIC ON SPIDERS.

IMMATURE Spiders of the species *Epeïra antriada*, *Epeïra inclinata*, *Epeïra cucurbitina*, and *Epeïra diadema*, and adults of the species *Linyphia minuta* and *Linyphia tenuis*, are frequently infested by the larva of the *Polysphincta carbonaria* of Gravenhorst, which feeds upon their fluids and ultimately occasions their death. This parasite is always attached to the upper part of the abdomen, near its union with the cephalothorax, generally in a transverse but occasionally in a longitudinal direction; and, though it proves a source of constant irritation, is secured by its position from every attempt of the spider to displace it. Being apodous, it appears to retain its hold upon its victim solely by the instrumentality of the mouth and of a viscid secretion emitted from its caudal extremity. I never saw more than a single larva on the same individual spider, which, indeed, could not supply sufficient nourishment for two.

In the earlier stages of its growth this parasite has

an oblong oviform figure, somewhat depressed on the underside; it is whitish, with a faint tinge of yellow extending along the medial line of the upper part, which seems to be occasioned by the contents of the viscera. At this period of its existence the external covering presents a smooth, uniform surface; but when its has completed its moultings and attained to its full size, the head becomes visible, the body exhibits thirteen distinct segments, a series of dorsal prolegs is developed on the segments comprised between the third and tenth, both inclusive, and its prevailing hue is dark brown streaked and spotted with white, particularly on the sides. The dorsal prolegs are short, and, with the exception of that on the tenth segment, are more or less bifid at the summit; on their extremities numerous fine curved processes or claws are disposed, with which the larva, when about to fabricate its cocoon, attaches itself to the lines spun by its victim. Only two instances are noticed by Messrs. Kirby and Spence in their 'Introduction to Entomology,' sixth edition, vol. ii. pp. 227, 228, of the larvæ of insects having prolegs situated on their backs.

In April 1838, I captured a young female *Epeïra antriada* with one of these parasites upon it, and placing it in a phial of transparent glass, I supplied it with flies. Towards the end of May, having gone through its final moult and increased considerably in size, this larva became very restless, and on the 29th

quitted the spider, which was found dead and much shrunk at the bottom of the phial, and attaching itself to the extremity of the cork with which the phial was stopped, it began to spin its envelope. On the 31st it had completed its cocoon, which was composed of pale yellowish-white silk of a compact texture, and measured one third of an inch in length and one tenth in diameter; it was of an oblong quadrilateral figure, tapering to its extremities, one of which was more pointed than the other, and was connected with the cork by numerous fine silken lines. The perfect insect came out of the cocoon, at the larger end, on the 27th of June, and proved to be a female.

The length of this insect from the anterior part of the head to the extremity of the abdomen, not including the ovipositor, was one fourth of an inch; the breadth from tip to tip of the anterior wings, when expanded, $\frac{11}{24}$. The antennæ were filiform, and had each twenty-four joints. The maxillary palpi had five joints, and the labial palpi four. The tibiæ were terminated by two spurs on the underside. The tarsi had five joints, of which the penultimate was the shortest, and the claw-joint was provided with two curved claws and a pulvillus. The head, antennæ, and several parts of the trunk were of a brownish-black colour, with the exception of the organs of manducation, which had a brown hue. An oblong, soot-coloured spot occurred near the ex-

terior margin of each anterior wing, a little beyond the middle towards the extremity. The legs and the maxillary and labial palpi were of a yellowish-brown colour, the tarsi and the extremities of the tibiæ of the posterior legs excepted, which had a brown hue. The abdomen consisted of eight segments: the first, which was the longest, was rather narrow and of a brownish-black colour; the others had a dark brown hue above, but the posterior margins of the second, third, fourth, and fifth were much the darkest. The caudal or terminal segment was the shortest, and had a small hairy process on each side at the extremity. All the segments, except the first, were of a pale brown colour on the underside of the abdomen. The ovipositor was hairy, of a very dark brown hue, and measured $\frac{1}{24}$ of an inch in length.

On the 20th of July, 1838, I obtained a young female *Epeïra antriada*, to whose abdomen a full-grown larva of this insect was attached, and placed it in a phial. On the 23rd the larva became restless and destroyed the spider, after having reduced it to a mere corrugated skin; then quitting it, and taking its station on the extremity of the cork which stopped the phial, it commenced spinning its cocoon, and completed it on the 24th. Out of this cocoon, which exactly resembled the one described above in figure and colour, though it was somewhat less, a male *Polysphincta carbonaria* issued on the 16th of August.

This insect was without an ovipositor, and was

smaller than the female bred from the larva found on the female *Epeïra antriada* captured in April 1838; its antennæ also had each twenty-two joints only; but these differences may be regarded as sexual peculiarities merely; the close resemblance of the two insects in other particulars, and the exact correspondence in the economy of their larvæ, leave no doubt about their specific identity.

On the 26th of October, 1841, I caught an adult female *Linyphia minuta* with a parasitic larva, which had completed its moulting, fixed upon its abdomen, and enclosing it in a phial, I fed it with flies. The larva increased in growth till the 1st of February, 1842, when it destroyed the spider, which was much reduced in size, and having quitted it, attached itself to the underside of a slight, horizontal sheet of web previously constructed in the phial by the spider. In this situation it remained till the evening of the same day, when it commenced spinning its cocoon, and on the evening of the day following had completed it. This cocoon was composed of brown silk of a compact texture, and was of an oblong, quadrilateral form tapering to its extremities, one of which was more pointed than the other.

As this insect did not go through its final metamorphosis, I am unable to decide whether it differed specifically from those already described or not; but it is very probable that it did not, as the dissimilarity in the colour of the silk composing its cocoon may be

reasonably ascribed to the quality of the food derived from a different species of spider; for it is a well-known fact that animal secretions are frequently modified in colour by changes of diet.

It is deserving of notice that immature spiders infested with the larva of *Polysphincta carbonaria* do not change their skin. Were it not for this admirable provision of Providence, the larva, cast off with the integument in the act of moulting, would inevitably perish, and the important purpose which its remarkable economy is so evidently intended to subserve (namely, the keeping of these deadly enemies of the insect tribes within due limits) would fail to be accomplished.

Various circumstances concur to render it probable that *Polysphincta carbonaria* deposits its eggs on spiders in the autumn, attaching one only to the abdomen of each individual.

Messrs. Kirby and Spence, in treating on the diseases of insects in the fourth volume of their 'Introduction to Entomology' *, have given a brief account of observations made by De Geer on the larva of a small *Ichneumon* discovered on a young spider, whose economy is similar to that of the parasite which has engaged my attention.

Being desirous of ascertaining whether these insects were of the same species or not, and having no opportunity of consulting De Geer's celebrated work, I

* Fifth edition, letter xliv. pp. 221, 222.

availed myself of the assistance of Mr. Peter Barrow, of Manchester, who obligingly transcribed all that the Swedish entomologist had published on the subject, and transmitted it to me in Wales.

On perusing the description of the female *Ichneumon* bred from the larva which formed the subject of his investigations *, I found that it presented several decided points of difference in colour from the insect observed by me, from which it may be distinguished at once by the two longitudinal yellowish lines on its thorax.

It scarcely admits of a doubt that the whitish, oval object noticed by Baron Walckenaer on a specimen of *Linyphia montana* †, which seems to have induced no small degree of surprise and perplexity in the mind of that accomplished arachnologist, was the parasitic larva of a small species of *Ichneumon*.

* 'Mémoires pour servir à l'Histoire des Insectes,' tom. ii. p. 866.

† 'Histoire Naturelle des Insectes Aptères,' tom. i. p. 176.

EXPERIMENTS AND OBSERVATIONS

ON

THE POISON OF ANIMALS OF THE ORDER *ARANEIDEA*.

MUCH has been written about the deleterious property of the transparent colourless fluid emitted from the minute orifice situated near the extremity of the fangs of spiders on the side next to the mouth, when those instruments are employed to inflict a wound. The numerous accounts which have been published by various authors of the singular effects induced in the human species by the bite of the Tarentula (*Lycosa tarentula apuliæ*, Walck.), and of the still more extraordinary mode of cure, together with the serious and sometimes fatal consequences which have been attributed to the bite of the Malmignatte (*Latrodectus malmignatus*, Walck.), must be regarded as amusing fictions in the natural history of the *Araneidea*; and if the opinion, prevalent among arachnologists of the present day, that insects pierced by the fangs of spiders die almost instantaneously, should be found

on examination to be at variance with well-ascertained facts, it must in like manner be deemed fanciful.

For the purpose of testing the validity of this opinion, which I had reason to doubt, and in order to determine, with a nearer approximation to accuracy than had previously been done, some of the effects produced under divers circumstances by the poison of spiders, more especially the degree of influence it exercises in destroying the vital functions of animals, in the summer of 1846 I commenced an experimental investigation of the subject, the particulars of which are comprised in the following pages.

To avoid confusion, the experiments have been arranged under four distinct heads, corresponding to the objects upon which they were made—namely, the human species, spiders, insects, and inanimate substances. It may be proper to premise that all the animals were adult individuals in vigorous health, and that the temperature of the atmosphere, in every instance recorded, was ascertained by means of a thermometer graduated according to Fahrenheit's scale, and exposed to the open air in a shady situation having a northern aspect.

1. *Experiments on the Human Species.*

On the 19th of July, 1846, a female *Epeïra diadema* was induced to bite me on the inner side of the left hand, near the base of the fore finger; it continued to force its fangs deeper into the flesh during a period

of many seconds, and at last quitted its hold voluntarily, when a little blood issued from the wounds it had inflicted. Though the spider was in a state of great excitement from previous irritation, yet I did not experience more inconvenience from its bite than from a puncture made near it at the same time with a fine needle; indeed, allowing for a considerable degree of compression in the former case, the effects of both injuries appeared to be very similar. The thermometer, while the experiment was in progress, stood at 76°; the air throughout the day was sultry, and an extensive thunder-storm occurred in the evening.

A highly exasperated female *Epeïra diadema* was allowed to seize me on the inner side of the left forearm, near the carpus, on the 30th of July, 1846. It continued for more than a minute to bury its fangs deeper in the flesh, and on quitting its hold voluntarily a little blood flowed from the wounded part, near which a puncture was made simultaneously with a fine needle. The air was sultry, the temperature at the time being 75°, and distant thunder was heard. No difference was perceptible between the results of this and the preceding experiment.

At 11^{h} 30^{m} A.M. on the 22nd of August, 1846, the thermometer at the time indicating a temperature of 65°, a powerful and much-irritated female *Epeïra quadrata* bit me on the inner side of the left forearm, near the carpus. It retained its hold for the

space of five minutes, occasionally forcing its fangs deeper into the flesh, and on quitting it voluntarily blood issued freely from the punctures. Due allowance being made for the strong degree of compression employed by this robust spider, the effects of its bite did not differ materially from those of a wound made near it at the same time with a needle of an average size, the intensity and duration of the pain being very similar in both instances.

On several occasions, in the month of August, 1846, spiders of various species were induced, under the influence of excited feelings, to seize a piece of clean window-glass with their fangs, when the transparent fluid which escaped from the small aperture near their extremity was deposited upon it. The application of this fluid to the tongue did not produce any sensible effect on that organ; but the result was very different when the poison emitted under like circumstances from the sting of the common Wasp (*Vespa vulgaris*), the Hive-bee (*Apis mellifica*), or the Humble bee (*Bombus terrestris*) was so applied, a powerfully acrid pungent taste being the immediate consequence. A contrast equally remarkable was evinced when these fluids were transmitted into a recent wound—that secreted by the insects caused inflammation accompanied by acute pain; effects which if produced at all by that secreted by the spiders, were scarcely appreciable.

The legitimate conclusion deducible from the ex-

periments seems to be, that there is nothing to apprehend from the bite of the most powerful British spiders, even when inflicted at a moment of extreme irritation and in hot sultry weather, the pain occasioned by it being little, if any, more than is due to the laceration and compression the injured part has sustained.

The manner in which spiders are affected when pierced by the fangs of animals of their own order demands attention in the next place.

2. *Experiments on Spiders.*

On the 22nd of July, 1846, a male *Tegenaria civilis*, in a violent struggle with a female of the same species, deeply inserted his fangs near the middle of the dorsal region of her abdomen, and retained his hold for several seconds; from the punctures thus made a brown fluid issued copiously, and in a few minutes coagulated. The injured spider appeared to suffer very little from the severe wounds it had received, as it speedily constructed a small web in the phial in which it was confined, and continued for more than a year to feed freely on the flies introduced to it. The thermometer, at the time the experiment was made, indicated a temperature of 74°.

In a hostile encounter between two female spiders of the species *Segestria senoculata*, on the 29th of

July, 1846, one of them was pierced by the fangs of her opponent on the underside of the abdomen, near the spinners. A transparent colourless fluid oozed from the wounds for many minutes, and ultimately coagulated; but the spider seemed to experience little inconvenience from the injury, being lively in its motions and preying eagerly upon the insects with which it was supplied. The temperature at the time was 76°, and the atmosphere was highly electrical.

A female *Ciniflo atrox* was bitten by an exasperated female *Lycosa agretyca* near the middle of the cephalothorax, on the 29th of July, 1846, the temperature by the thermometer being 76°. The *Lycosa* retained its hold for many seconds, and on quitting it voluntarily a transparent colourless fluid flowed from the punctures and coagulated. The wounded spider, apparently regardless of the injury it had received, spun a web with which it long continued to ensnare its victims.

On the same day, the mercury in the thermometer denoting a temperature of 75°, a female *Epeïra diadema*, in a violent struggle with a female *Cœlotes saxatilis*, pierced her abdomen in the medial line of the dorsal region, about a third of its length from the spinners. The wounded spider did not exhibit any marked symptoms of distress and speedily resumed its accustomed habits.

In an attack made by a female *Ciniflo ferox* upon a

female *Lycosa agretyca,* on the 30th of July, 1846, the temperature being 74°, the latter was wounded by the fangs of its assailant at the base of the coxa of the left posterior leg, and a transparent fluid, which soon coagulated, issued from the injured part. Nothing occurred afterwards to indicate that the *Lycosa* had suffered from the encounter.

Two female spiders of the species *Epeïra diadema* engaged in a severe contest on the 30th of July, 1846, the thermometer standing at 73°, when one of them was seized by the fangs of her antagonist near the middle of the right side of the abdomen. A brown fluid flowed from the punctures and soon coagulated, but the spider appeared to be only slightly and very briefly affected by the injury.

A female *Epeïra diadema,* in a highly excited state, bit itself near the middle of the femur of the left anterior leg, on the 5th of September, 1846. The temperature at the time was 69°, and a transparent fluid flowed copiously from the wounded part; coagulation, however, quickly ensued, after which the spider manifested no unfavourable symptom whatever.

Extensive mechanical injuries commonly prove fatal to spiders, whether received in conflicts with their congeners or otherwise, the extinction of life being more or less rapid in proportion to the vitality of the part lacerated; but no evidence supplied by the foregoing experiments indicates that the fluid emitted from the orifice in the fangs of the *Araneidea*

possesses a property destructive to the existence of animals of that order when transmitted into a recent wound; in short, it does not appear to exercise any greater degree of influence upon them than it does upon the human species.

I now proceed to show how insects are affected when pierced by the fangs of spiders.

3. *Experiments on Insects.*

1846. August 7th. A female *Epeïra diadema* inflicted a severe wound on the mesonotum of a common Wasp, near the base of the right anterior wing, at 11^h A.M., the temperature at the time being 74°. The wasp, though disabled from flying, survived the injury for the space of thirteen hours.

August 7th. At 1^h 30^m P.M., the temperature being 72°, a female *Epeïra diadema* pierced a Humble bee (*Bombus terrestris*) with its fangs near the posterior part of the mesosternum. The wound deprived the humble bee of the power of flight, but did not terminate fatally till 11^h P.M. on the 10th.

August 8th. Temperature 68°. A female *Segestria senoculata* seized a Flesh-fly (*Musca vomitoria*) near the middle of the tibia of the right posterior leg, and did not quit its hold for several seconds. A transparent colourless fluid issued from the wounds made by the fangs of the spider; but the fly retained the use of its wings, and did not expire till evening on the 10th.

August 13th. Temperature 64°. At 5^h 15^m P.M. a female *Segestria senoculata* inserted its fangs about the middle of the abdomen of a large Green Grasshopper (*Acrida viridissima*), and retained its hold, which it quitted voluntarily, for many seconds. A greenish-yellow fluid flowed copiously from the punctures; yet the insect continued to be lively in its movements, leaping with agility up and down the glass vessel in which it was confined, and ceased not to exist till midnight on the 15th.

August 14th. Temperature 66°. A female *Epeïra diadema* pierced a large Green Grasshopper at 4^h 43^m P.M., burying one fang at the base of the antenna on the right side, and the other in the right eye. The spider retained its hold for several seconds, and on quitting it a greenish-yellow fluid issued from the former wound and a dark brown fluid from the latter. Notwithstanding the serious injuries the grasshopper had received, no diminution of its activity was apparent, and it did not expire till afternoon on the 16th.

August 29th. Temperature 69°. At 1^h 22^m P.M. a Hive-bee had its abdomen extensively lacerated near the middle of the left side by a female *Epeïra quadrata*. A large quantity of transparent fluid flowed from the wound, but death did not ensue till 3^h 18^m P.M.

September 3rd. Temperature 68°. A common Crane-fly (*Tipula oleracea*) punctured by the fangs of

a female *Segestria senoculata*, at 4^h 35^m P.M., about a quarter of an inch from the posterior extremity of its abdomen, survived till 8^h 7^m P.M.

September 7th. Temperature 69°. At 1^h 45^m P.M. a Flesh-fly was bitten by a female *Epeïra diadema* on the underside of the abdomen, near its posterior extremity, and a brownish fluid continued to ooze from the wounds till 5^h 18^m P.M. on the 8th, when the fly expired.

September 7th. Temperature 68°. A common Crane-fly was seized near the posterior extremity of the abdomen, at 4^h 54^m P.M., by a female *Epeïra quadrata*. A brownish fluid issued from the punctures made by the fangs of the spider, and the existence of the insect terminated at 6^h 9^m P.M. on the 8th.

September 10th. Temperature 64°. Pierced a Flesh-fly through the middle of the left side of the abdomen with a fine needle, at 12^h 14^m P.M.; a transparent fluid issued from the wound, which the fly survived till 4^h 20^m P.M. on the 11th.

September 10th. Temperature 65°. At 1^h 13^m P.M. a common Crane-fly was pierced through the left side of the abdomen, near the middle, with a fine needle; the insect expired on the same day at 5^h 29^m P.M.

September 10th. Temperature 65°. The point of a strong needle was deeply inserted into the right side of the abdomen of a large Green Grasshopper,

near its anterior extremity, at $1^h\ 20^m$ P.M. Though the injury was severe, the life of the insect did not become extinct till $7^h\ 41^m$ P.M. on the 12th.

September 10th. Temperature 66°. The right side of the abdomen of a common Wasp was penetrated near the middle with the point of a fine needle, at $2^h\ 5^m$ P.M.; a transparent fluid oozed from the puncture, and the life of the wasp terminated at $10^h\ 20^m$ P.M.

September 18th. Temperature 60°. A male *Tegenaria civilis* deeply inserted its fangs near the middle of the mesonotum of a House-fly (*Musca domestica*) at $10^h\ 10^m$ A.M., and retained its hold for more than an hour and a half. The victim continued to manifest unequivocal signs of life till $10^h\ 44^m$ A.M., and appeared to sink gradually from mere exhaustion. All the time it was in the grasp of its enemy, with the exception of short intervals, it was perceived to have a slight nodding motion, which was discovered to be caused by the act of deglutition on the part of the spider, a synchronous motion being always observed in the fluid suddenly and copiously propelled into the spider's mouth, and then by degrees reduced in volume in exact proportion to the continuance of the nutation. Whenever the fluid was withdrawn from the mouth a fresh supply was speedily introduced, and after mingling with that extracted from the body of the fly, was conveyed into the stomach of the spider by a repetition of the act of swallowing,

thus occasioning the nodding motion with intervals of repose apparent in its prey.

September 18th. Temperature 61°. At $10^h\ 20^m$ A.M. a female *Tegenaria civilis* seized a House-fly with its fangs near the middle of the mesonotum, and did not relax its hold for more than an hour. The struggles of the fly became gradually more feeble, till they ceased altogether at $10^h\ 47^m$ A.M. The nodding motion of the victim, and all the attendant circumstances, were as conspicuous in this instance as in the preceding one.

September 18th. Temperature 64°. A female *Segestria senoculata* penetrated with its fangs the right side of the mesonotum of a House-fly at 1^h P.M., but did not deprive it of life till $1^h\ 29^m$ P.M. The spider kept its hold about an hour; and a nodding motion of the fly, regularly accompanied by the act of deglutition in its destroyer, with brief and simultaneous pauses in both, was observed during the entire period.

1847. July 15th. Temperature 71°. At $5^h\ 3^m$ P.M. a brilliant Green Fly (*Musca cæsar*) was pierced by the fangs of a female *Agelena labyrinthica* near the posterior extremity of the abdomen, on the underside. After retaining its hold about ten minutes the spider transferred it to the middle of the mesosternum, perforating the part and rapidly extracting the fluids of its prey, whose existence terminated at $5^h\ 26^m$ P.M. A nutation of the fly was constantly

observed to accompany the action of swallowing in its adversary.

July 19th. Temperature 70°. A female *Agelena labyrinthica* struck its fangs into the left side of the mesonotum of a Flesh-fly, at $12^h\ 23^m$ P.M., and eagerly extracted its fluids, the act of deglutition being attended with the usual nodding motion of the victim. After ineffectual efforts to escape, the insect became exhausted, and finally expired at $12^h\ 43^m$ P.M.

These experiments do not present any facts which appear to sanction the opinion that insects are deprived of life with much greater celerity when pierced by the fangs of spiders than when lacerated mechanically to an equal extent by other means, regard being had in both cases to the vitality of the part injured, as the speed with which existence terminates mainly depends upon that circumstance. It is true that the catastrophe is greatly accelerated if spiders maintain a protracted hold of their victims; but this result is obviously attributable to the extraction of their fluids, which are transferred by oft-repeated acts of deglutition into the stomachs of their adversaries.

From the entire mass of evidence supplied by the experiments taken in the aggregate, it may be fairly inferred that whatever properties characterize the fluid emitted from the orifice in the fangs of the Araneidea, it does not possess that degree of virulence which is commonly ascribed to it, neither is it so destructive to animal life when transmitted into a recent

wound as it is generally supposed to be. Were I disposed to speculate upon the manner in which it affects insects on being introduced by the fangs into their vascular system, I might conjecture that it has a tendency to paralyze their organs of voluntary motion, and to induce a determination of their fluids to the part injured; but I refrain from dwelling upon a suggestion, however plausible it may appear to be, which, in the present state of our knowledge of the subject, can only be regarded as hypothetical.

4. *Experiments on Inanimate Substances.*

In the month of September 1846, litmus paper presented to spiders belonging to several genera when in a state of extreme irritation, having their fangs extended, and the transparent fluid which issues from the fissure near their extremity conspicuously accumulated there, on being seized invariably became red as far as the fluid spread round the punctures made in it, a result clearly proving that this animal secretion, though tastless, is an acid. Care, however, must be taken, in conducting the experiment, not to suffer any fluid from the mouth to blend with that which proceeds from the fangs, either before or after it has been transferred to the litmus paper, the former, rendering the blue colour of the test more intense, and restoring it after it has been converted to red by the action of acetous acid, being decidedly an alkali; con-

sequently, if both combined in due proportions, they would neutralize each other; but as there is usually a much more copious supply of the alkaline than of the acid fluid, its agency would predominate, and scarcely a trace of red would be discerned on the litmus paper.

Submitted to the same chemical tests, the fluid contained in the stomachs of spiders and that which flows from wounds inflicted on their bodies and limbs were found to be alkaline. Now if the frequency and suddenness with which large quantities of fluid are propelled into the mouths of spiders when occupied in extracting nutriment from their prey be borne in mind, the conclusion that they must be ejected from the stomach through the narrow œsophagus and pharynx seems to be inevitable*, as there is not any other source known whence they could be derived; and it has been ascertained that if they are applied to litmus paper, which has or has not been reddened by acetous acid, they always produce upon it effects precisely similar to those caused by the gastric fluid, or rather by the fluid contents of the stomach, when subjected to such tests. I may remark that the yellow colour

* The statement of Savigny, that some spiders have three pharyngeal apertures, does not appear to be applicable to several of our larger indigenous species, as I have not been able to detect more than one such aperture in *Ciniflo ferox*, *Cœlotes saxatilis*, *Tegenaria civilis*, *Agelena labyrinthica*, and *Epëira quadrata*, on the most careful inspection.

of turmeric paper is rendered brown by the application of the fluids from the mouth and stomach, and that it is restored again by the agency of the fluid secreted by the poison-glands, changes which afford another proof, in addition to those already advanced, of the respective alkaline and acid properties of these animal products.

The instruments employed by the Araneidea to seize and destroy their prey are improperly denominated mandibles; I say improperly, because they actually do not constitute any part of the oral apparatus, as Mr. W. S. MacLeay has plainly asserted †; indeed many eminent zootomists, judging from their position and from the origin of the nerves distributed to them, entertain the highly probable opinion that they are the analogues of the antennæ of hexapod insects, and in accordance with this view of the subject M. Latreille termed them *chelicera*; but so widely do they differ from antennæ in structure and function, that the propriety of bestowing upon them a distinct appellation which does not imply any thing hypothetical will scarcely be questioned: I propose, therefore, to name them *falces*.

Much of the misapprehension that exists among arachnologists relative to the *falces* has been occasioned, in all probability, either by the prevailing

† 'Annals and Magazine of Natural History,' 1839, vol. ii. p. 2, note *.

belief that spiders are destitute of a labrum, or by mistaken notions as to its precise situation. That they possess the organ in a low state of development is undeniable, as I have distinctly observed it in species belonging to the genera *Lycosa*, *Dolomedes*, *Salticus*, *Thomisus*, *Olios*, *Drassus*, *Clubiona*, *Ciniflo*, *Agelena*, *Tegenaria*, *Cœlotes*, *Theridion*, *Linyphia*, *Epeïra*, *Dysdera*, and *Segestria* *. It is attached by its base to the superior surface of the palate; but the extremity, which is free, and usually round or somewhat pointed, can be slightly elevated, depressed, extended, retracted, and moved laterally at will. To apply the term mandibles to organs originating above the labrum, and therefore not situated within the mouth, must evidently be erroneous; and I venture to anticipate, upon anatomical considerations, that future investigations will lead to the conclusion that the mandibles of the Araneidea are confluent with the palate.

* Professor Owen has detected a rudimental labrum in spiders of the genus *Mygale*. See his 'Lectures on Comparative Anatomy' (1st ed.), Lecture xix. Arachnida, p. 257.

OBSERVATIONS AND EXPERIMENTS

ON

AËRONAUTIC SPIDERS,

MADE CHIEFLY WITH A VIEW

TO ASCERTAIN THE MEANS BY WHICH THEY EFFECT THEIR AËRIAL EXCURSIONS.

ALTHOUGH it is well known that spiders frequently ascend into the atmosphere through the instrumentality of fine lines formed of a viscid secretion, which proceeds from the mammulæ situated at the extremity of the abdomen, yet the manner in which these aërial journeys are effected still remains involved in obscurity, and considerable diversity of opinion exists as to the particular species of spider by which they are undertaken. This deficiency leaves open a wide field for speculation; and, accordingly, we find that natural historians have ascribed this interesting occurrence to several distinct causes, such as the agency of winds, evaporation, and electricity, the exercise of peculiar physical powers with which aëronautic spiders have been supposed to be endowed, and the extreme

levity of the lines of those animals, which are represented, by some writers on the subject, to be of less specific gravity than atmospheric air*: but that each of these hypotheses is unfounded, and in direct opposition to facts, will be rendered evident by the following observations and experiments, from which I have endeavoured to elicit a satisfactory solution of the difficulty.

That gossamer, which usually abounds most in the months of September and October, is perceived to ascend into the atmosphere only in serene, bright weather, is, I believe, generally allowed: it is also admitted that gossamer in the air is invariably preceded by gossamer on the ground. These, as will appear in the sequel, are circumstances of much importance in the present investigation, every method of accounting for the ascent of gossamer-webs and spiders, however plausible, which does not imply their concurrence being necessarily erroneous.

But to proceed to my own researches. A little before noon, on the 1st of October, 1826, which was a remarkably calm, sunny day, the thermometer in the shade ranging from 55°·5 to 64°, I observed that the fields and hedges in the neighbourhood of Manchester were covered over, by the united labours of an immense multitude of spiders, with a profusion of

* For a more detailed statement of the above conjectures, see the 'Introduction to Entomology,' by Messrs. Kirby and Spence, Letter xxiii.

fine, glossy lines, intersecting one another at every angle, and forming a confused kind of network. So extremely numerous were these slender filaments, that in walking across a small pasture my feet and ankles were thickly coated with them. It was evident, however, notwithstanding their great abundance, that they must have been produced in a very short space of time, as early in the morning they were not sufficiently conspicuous to attract my notice; and on the 30th of September they could not have existed at all, for, on referring to my Meteorological Journal, I find that a strong gale from the south prevailed during the greater part of that day.

A circumstance so extraordinary could not fail to excite curiosity; but what more particularly arrested my attention was the ascent of an amazing quantity of webs, of an irregular, complicated structure, resembling ravelled silk of the finest quality and clearest white. They were of various shapes and dimensions, some of the longest measuring upwards of five feet in length, and several inches in breadth in the widest part; while others were almost as broad as long, presenting an area of a few square inches only. These webs, it was quickly perceived, were not formed in the air, as is generally believed, but at the earth's surface. The lines of which they were composed, being brought into contact by the mechanical action of gentle airs, adhered together, till by continual additions they were accumulated into flakes or masses

of considerable magnitude, on which the ascending current, occasioned by the rarefaction of the air contiguous to the heated ground, acted with so much force as to separate them from the objects to which they were attached, raising them in the atmosphere to a perpendicular height of at least several hundred feet. I collected a number of these webs, about midday, as they rose, and again, in the afternoon, when the upward current had ceased to support them and they were falling; but scarcely one in twenty contained a spider, though, on minute inspection, I found small winged insects, chiefly Aphides, entangled in most of them.

From contemplating this unusual display of gossamer, my thoughts were naturally directed to the animals which produced it; and the countless myriads in which they swarmed almost created as much surprise as the singular occupation that engrossed them. Apparently actuated by the same impulse, all were intent upon traversing the regions of air; accordingly, after gaining the summits of various objects, as blades of grass, stubble, rails, gates, &c., by the slow and laborious process of climbing, they raised themselves still higher by straightening their limbs; and elevating the abdomen, by bringing it from the usual horizontal position into one almost perpendicular, they emitted from their spinning-apparatus a small quantity of the glutinous secretion with which they fabricate their silken tissues. This viscid substance,

being drawn out by the ascending current of rarefied air into fine lines several feet in length, was carried upwards, until the spiders, feeling themselves acted upon with sufficient force in that direction, quitted their hold of the objects on which they stood, and commenced their journey by mounting aloft.

Whenever the lines became inadequate to the purpose for which they were intended, by adhering to any fixed body, they were immediately detached from the spinners, and so converted into terrestrial gossamer, by means of the posterior pair of legs, and the proceedings just described were repeated, which plainly proves that these operations result from a strong desire felt by the spiders to effect an ascent. But what, it may be asked, is the exciting cause of this singular propensity? It has been suggested that hunger, or an inclination to procure some favourite kind of food, may supply the requisite stimulus. These suppositions, however, are discountenanced by the plump appearance which the animals exhibit, by their total disregard of such winged insects as happen to be placed within their power, by their utter inability to regulate their motions, while afloat, in any other manner than by letting out or drawing in the lines by which they are conveyed through the air, and thus promoting their ascent or descent, by the unsuitableness of the lines for securing their prey, and, lastly, by the uncertainty when a favourable day for their purpose may occur, or even that one may

occur at all. Were I to hazard a conjecture on the subject, I should be disposed to attribute the manifest anxiety of these animals to change their quarters to a feeling of insecurity occasioned by their proximity to one another, the prodigious numbers which in favourable seasons are usually congregated together affording the more powerful individuals an opportunity, seldom neglected by these voracious creatures, of making an easy prey of the weaker; and this opinion is strengthened, if not confirmed, by the fact that they are chiefly spiders which have not arrived at maturity that undertake these migrations.

I have asserted that when Aëronautic Spiders perform their aërial journeys they are borne upwards by an ascending current of rarefied air impinging against the slender lines which proceed from their spinners. I shall now endeavour to demonstrate that this curious atmospherical phenomenon, which well deserves the attention of meteorologists, affords them the only available means of accomplishing their object, and that the hypotheses previouly adverted to are quite irreconcilable with facts, and, consequently, must be erroneous.

It has been already stated that gossamer is never seen floating in the air except in calm sunny weather; its buoyancy, therefore, evidently does not depend upon the agency of winds, usually so called: indeed it is probable that winds never do take an upward direction, unless influenced by some extraordinary

circumstance or local peculiarity; the ascent of gossamer, on the contrary, is frequently observed to take place over a great extent of country on the same day. It was noticed on the 1st of October, 1826, for example, in England, Wales, and Ireland.

If a satisfactory explanation of this interesting fact cannot be derived from the operation of winds, it is still less likely to be deduced from the action of evaporation or electricity; for, not to insist upon the probable, I had almost said absolute, insufficiency of these powers, considered as agents, experiments show that spiders do not select those periods for making an ascent when the evaporating force is unusually great or the electricity of the atmosphere is remarkable for its intensity*. I find, likewise, that when gossamer-webs and the larger species of Aëronautic Spiders are raised into the air with facility, the downy feathers of birds and seeds of plants are also carried upwards, whatever may be their electrical condition as induced by artificial means—a convincing proof that the buoyancy of these several objects does not depend upon the influence of elec-

* The evaporating force may be determined by the atmometer, or from the temperature at which the aqueous vapour in the atmosphere begins to be condensed into water, and the temperature of the air (see the 'Memoirs of the Literary and Philosophical Society of Manchester,' 1st series, vol. v. part II, p. 588). The electrical state of the atmosphere is shown by Bennet's gold-leaf electrometer.

tricity. But though each of the alleged causes just adverted to appears to be incompetent to produce the required effect, yet one abundantly adequate may, perhaps, be thought to exist in the physical endowments of the animals themselves, or in the extreme lightness of their filaments; these two last-named suppositions, therefore, merit a careful examination.

If spiders do impel their lines upwards by the voluntary exercise of some animal function which has hitherto eluded the researches of physiologists, it follows that when the communication is interrupted, the lines, unless influenced by some other force, must necessarily fall. Now the reverse of this uniformly ensues; for if the animals, after having commenced their ascent, are suddenly separated from the lines to which they are attached, the latter still continue to ascend, their motion being accelerated by the diminished action of gravity upon them, but the former are rapidly precipitated to the ground. The conclusion is obvious. The buoyancy of the lines cannot be occasioned by the beings which produce them; and the ascent of large flakes of web unoccupied by spiders, before alluded to, confirms this opinion.

Perhaps the buoyancy of lines from which spiders have been detached, and of webs altogether destitute of those animals, may be regarded as facts powerfully contributing to establish the accuracy of the idea that this secretion is specifically lighter than the mixed gases which compose the atmosphere. The

fallacy of this notion, however, is easily detected by experiment. In the comparatively still air of a room without fire, both the lines and webs descend slowly to the floor, the latter falling with the greater degree of velocity. Were these productions lighter than atmospheric air, or were the spiders capable of effecting an ascent without adventitious aid, a calm though cloudy day might answer their purpose; but as considerable warmth is required to produce an ascending current of rarefied air strong enough to bear them from the earth, a bright as well as still day is indispensable.

A distinguished French naturalist, M. Virey, gives the following results of his observations and experiments on Aëronautic Spiders, in the 'Bulletin des Sciences Naturelles' for October, 1829, p. 133:—"Réfléchissant aux moyens par lesquels ces insectes gravissent dans l'air, une seule chose m'a paru la plus vraisemblable, c'est qu'à l'aide des huit pattes que l'animal peut faire vibrer avec agilité, *il nage dans l'air*. On conçoit que ces membres rapprochés, ramant quatre à quatre simultanément de chaque côté, frappent l'air comme des aîles, et peuvent fort bien enlever cet insecte d'ailleurs si léger. Ce procédé paraît le seul possible dans ce cas. D'ailleurs l'extrême rapidité, ou l'agilité incroyable de ces pattes en trépidation, comme la vibration des aîles chez les oiseaux ou les insectes diptères qui planent dans l'air, font qu'on ne peut pas toujours bien distinguer leur

mouvement." In this bold but fanciful conjecture, M. Virey has been anticipated by our celebrated countryman Dr. Lister, who, in treating upon his "araneus subfuscus, minutissimis oculis è violâ purpurascentibus, tardipes, & gressu & figurâ cancro marino non adeò dissimilis," remarks, "certè egregius funambulus est, & mirificè filorum ejaculatione delectatur: neque solùm in aëre, utì superiores, vehitur; sed ipse etiam ascensum velificationémque molitur, pedibus scilicet arctiùs ad se invicem applicitis sese quodammodo librat, cursum promovet regitque nihilo seciùs quàm si illi essent à naturâ concessæ alæ vel remorum ordines"*. Supported by such high authorities as these, this hypothesis assumes an air of importance to which it is not otherwise entitled, since the single fact that spiders, when sailing in the atmosphere, invariably fall to the ground on being separated from their lines, is alone sufficient to effect its complete subversion. Moreover, I have thoroughly satisfied myself, by much elaborate investigation, that spiders never ascend into the air spontaneously without the assistance of lines connected with the spinners, and that when they perform their aërial journeys their legs are usually in a state of quiescence, being contracted and brought into close contact with the body: indeed, should the limbs happen to be observed in motion, they will generally be found, on minute inspection, to be employed in

* 'De Araneis,' p. 85.

adjusting the suspensory filaments, and not in propelling the adventurous aëronauts through the atmosphere. It is manifest, therefore, that, in the strict sense of the word, spiders do not fly.

The various directions in which spiders sail through the atmosphere admit of an easy explanation. A direction parallel to the horizon will be given by a current of air moving in that plane; a vertical one by the ascent of air highly rarefied; and directions intermediate between these two will, in general, depend upon the composition of forces. When the horizontal and vertical currents are equal in force, the line of direction will describe an angle of 45° nearly with the plane of the horizon; but when their forces are unequal, the angle formed with that plane will be greater or less accordingly as one current or the other predominates.

Founded on results obtained from an experiment which has been frequently made, but never conducted with sufficient care, is the belief, entertained by many eminent naturalists, that spiders can forcibly propel or dart out lines from their papillæ. Now as this process would, contrary to my own experience, imply the exercise of a physical power peculiar to these creatures, and as attempts have been made to explain on this principle the fabrication of the nets of Geometric Spiders in situations where their ordinary mode of proceeding could not be employed, I determined to repeat the experiment from which so strange

a conclusion has been deduced. With this view, having procured some small branched twigs, I fixed them upright in glazed earthenware vessels with perpendicular sides, containing water, their bases being immersed in the liquid, and upon them I placed several Aëronautic and Geometric Spiders. Whenever the animals thus circumstanced were exposed to a current of air, either naturally or artificially produced, they directly turned the cephalothorax towards the quarter whence it came, even when it was so slight as scarcely to be perceptible; and elevating the abdomen, they emitted from their spinners a small quantity of glutinous matter, which was instantly carried out in a compound line, with a velocity equal, or nearly so, to that with which the air moved, as was apparent from observations made on the motion of detached lines similarly exposed. The spiders, in the next place, carefully ascertained whether their lines had become firmly attached to any object or not, by pulling them with the first pair of legs; and if the result was satisfactory, after tightening them sufficiently, they made them fast to the twigs; then discharging from their spinners, which they applied to the spot where they stood, a little more of their liquid gum, and committing themselves to these bridges of their own constructing, they passed over them in safety, drawing a second line after them as a security in case the first gave way, and so effected their escape. Such was invariably the result

when the spiders were placed where the air was liable to be sensibly agitated: I resolved, therefore, to put bell-glasses over them; and in this situation they remained seventeen days, evidently unable to produce a single line by which they could quit the twigs they occupied without encountering the water at their bases, though, on the removal of the bell-glasses, they regained their liberty with as much celerity as in the instances already recorded.

The manner in which the lines of spiders are carried out from the spinners by a current of air appears to be this. As a preparatory measure, the spinning-mammulæ are brought into close contact, and viscid matter is emitted from the papillæ; they are then separated by a lateral motion, which extends the viscid matter into fine filaments connecting the papillæ; on these filaments the current impinges, drawing them out from the spinners to a length which is regulated by the will of the animal; and on the mammulæ being again brought together the filaments coalesce and form one compound line.

The foregoing experiment, which, from a want of due precaution in its management, has misled so many distinguished naturalists, I have repeated with more than thirty distinct species of spiders, at all hours of the natural day, and in electrical and meteorological states of the atmosphere differing most essentially; in short, under every variety of circumstances which appeared likely to influence the result, yet always

with the same success. Placed under bell-glasses, or in any situation where the air remained tranquil, they in vain attempted to make their escape from the twigs to which they were confined, notwithstanding their best endeavours to quit them were persisted in pertinaciously; but in the disturbed atmosphere of an inhabited room most of them readily accomplished their object. I am confident, therefore, in affirming that the lines produced by spiders are not propelled from the spinners by any physical power possessed by those animals, but that they are invariably drawn from them by the mechanical action of external forces.

Spiders, though placed on excellent conductors of electricity, such as metallic rods insulated by water, if exposed to a current of air, let out their lines with facility, and *invariably in the direction of the breeze.* The act is perfectly voluntary, and the lines, immediately after they are emitted, nay, at the very time they are issuing from the spinners, if blown upon from any other quarter, instantly obey the new impulse thus imparted to them. I have tried this experiment on numerous occasions without once perceiving the slightest deviation from these results, which I, therefore, regard as completely established.

All spiders possessing an apparatus for spinning do not appear to be endowed with the instinct to let out their lines when placed on a twig insulated by water and exposed to a current of air; and as this is the

case with some of the more common species, with *Tegenaria civilis* and *Ciniflo atrox* for example, I take this opportunity of calling the attention of observers to the fact, which, if unnoticed, might occasion them some disappointment.

In conducting experiments similar to those described above, it will be very apparent that there is a decided advantage in employing, as I have recommended, vessels having smooth, perpendicular sides, care being taken not to fill them with water, for several kinds of spiders run upon that liquid with greater facility than they do on land; and though most of our larger indigenous species are, at least when they have attained their full growth, quite incapable of walking upon its surface, still they sometimes contrive to effect a passage over it by the following ingenious expedient. Placed on an insulated twig, they attach a line to it which they seize with the foot of one of the hind legs, allowing it to run freely through the claws as it proceeds from the spinners. Descending to the surface of the water, they use their best exertions to pass over it; and should a little dust or other extraneous matter happen to rest upon it, enabling them to obtain even a slight footing, their efforts are frequently attended with success, the line, which chiefly contributes to support them during their progress and also serves to secure a return to the twig should their attempts prove abortive, being ultimately made fast to the

edge of the vessel containing the liquid. Various species of spiders occasionally proceed down the twig into the water, and endeavour to walk over the bottom of the vessel, the atmospheric air confined among the hairs with which they are clothed, and enveloping in a greater or less degree their limbs and body, empowering them to remain immersed for a short period without suffering much inconvenience. When the experiments are made with Hunting-Spiders, a vessel of considerable internal dimensions should be selected; for, if this precaution be neglected, some species (*Salticus scenicus*, for example) will escape by leaping over the water intended to confine them; and on such occasions a line, attached by its extremity to the station previously occupied by each individual, is drawn out after it from the spinners.

Some Aëronautic Spiders, procured on the 2nd of October, 1826, were enclosed in glass phials with ground stoppers, where they were suffered to remain till the 16th of December, an interval of seventy-five days, without either food or moisture; yet, at the expiration of that period, the only alterations perceptible in their external condition were a small decrease in bulk and a slightly wrinkled appearance, particularly of the abdomen; but their functions were, seemingly, unimpaired; for on warm days, or when excited by artificial heat, they were lively in their motions, and to the last continued to produce their

lines, which were often destroyed for the purpose of ascertaining whether they would be replaced by others or not, with the same facility, apparently, as at the time of their capture. It is particularly deserving of notice that these animals, though unable to climb up the smooth perpendicular sides of the phials on their first introduction, soon contrived to traverse the interior of their prisons in every direction.

In order to illustrate their manner of proceeding on this occasion, the case of an individual has been selected for description, the same method, with a few trivial modifications, being pursued by all. Elevating the abdomen, and pressing the spinning-apparatus against the side of the phial, this spider emitted from its papillæ a little viscid fluid, which, on exposure to the air, hardened into a minute, semitransparent speck; then moving to a short distance, and drawing out a line after it, one end of which remained fixed to the spot it had just quitted, it connected this filament with another part of the phial by applying the spinners as before. Several lines being thus produced, the spider, speedily raising itself upon them above the bottom of the phial, promoted its undertaking by repeating the process just described, every step so gained enabling it to carry its operations still higher. From the cylindrical figure of the phial, it follows that all the lines attached to its sides by their extremities, such as were vertical alone excepted,

formed with those sides chords to arcs of various magnitudes. Lowering itself from one of these chords to another, and applying the spinners to each in succession, the spider soon connected the whole of them together by a line; then ascending again to the greatest altitude it could attain, and dropping down by a line to the bottom of the phial, over which it walked to the opposite side, it there drew the filament tight and made it fast, having prevented it from coming in contact with the glass previously by raising the abdomen a little. To this oblique line it united others, extending them in different directions, till, by these means, it established a communication with every part of the phial. As there was some difficulty in tracing these operations with the unassisted eye, lenses of the magnifying-powers of six and eight were employed.

The spiders seen ascending into the atmosphere on the 1st of October, 1826, were of two distinct species —the *Thomisus cristatus* of M. Walckenaer and the *Lycosa saccata* of M. Latreille. The species noticed by me as remarkable for the skill it displayed in spinning its way up the sides of the phial in which it was confined, and for having existed seventy-five days without food or moisture, was *Thomisus cristatus* —*Lycosa saccata* being neither so expert in climbing, nor so tenacious of life under similar circumstances. The largest individuals of the first species observed to undertake aërial journeys measured $\frac{1}{6}$ inch between

the extreme points of the head and abdomen, $\frac{1}{10}$ inch across the broadest part of the abdomen, and weighed about a quarter of a grain. The largest individuals of the second species seen floating in the air were of somewhat inferior weight and dimensions.

Aëronautic Spiders, properly so called, or those species which by *instinctively* employing their lines to sail in the atmosphere greatly facilitate and extend their geographical distribution, will probably be found chiefly among such as are active during the day and erratic. Numerous facts tend to corroborate this idea, the correctness or inaccuracy of which can only be determined by more extended observations.

ON THE MANNER

IN WHICH

THE GEOMETRIC SPIDERS

CONSTRUCT

THEIR NETS.

FEW animals of solitary habits are endowed with more extraordinary instincts than spiders. The ardent affection for their offspring so strikingly manifested by some species, the exquisite skill displayed by many in fabricating silken cocoons to contain their eggs and in the construction of their habitations, the highly curious contrivances by means of which others traverse the regions of air or descend beneath the surface of water, and the various stratagems had recourse to by all in eluding their numerous enemies and in securing their living prey, are eminently calculated to attract the attention and elicit the admiration of every person who has a mind alive to the wonderful physiological phenomena exhibited by the inferior orders of animated beings. But interesting as the general economy of this remarkable order of animals is, and

well deserving of more minute investigation than has hitherto been bestowed upon it, on the present occasion I propose to limit my observations to the manner in which several British species of *Epeïræ*, commonly denominated Geometric Spiders, construct their snares.

By the elegance of their symmetrical structure, and their extreme delicacy of texture, the nets of these uneducated geometricians never fail to excite astonishment, even in the most thoughtless observer; and the pen of the natural historian has been frequently employed in describing the singular process by which they are formed. Among the various authors whose works I have consulted, Messrs. Kirby and Spence have given the most circumstantial account of this process, in their comprehensive and excellent 'Introduction to Entomology,' vol. i. letter xiii.; I shall, therefore, avail myself of what those gentlemen have done, without reserve, introducing such particulars, in addition, as have resulted from my own researches, and attempting to solve a few of those difficulties which they have left without explanation.

The Geometric Spiders usually suspend their nets in an oblique or nearly vertical position, fixing them to trees, shrubs, plants, buildings, &c., in places where the insects they prey upon abound. After selecting a suitable situation for her purpose, the spider's first operation, in most instances, is to enclose an area,

the figure of which appears to be a matter of indifference, with lines of her own spinning. This is effected by proceeding along the objects immediately surrounding the space destined to be occupied by the net, and attaching to several points, by pressing the spinners against them, a line drawn out after her in her transit from one to another. These marginal lines she strengthens with a few additional ones, and finally gives them the requisite degree of tension by applying to them, in different directions, numerous smaller threads. Having thus completed the foundations of her snare, in the next place she commences to fill up the outline. Fixing a thread to one of the boundary lines, along which she walks, she guides the filament, produced in her progress, with one of her hind feet, that it may not touch in any part and adhere prematurely; and crossing over to the opposite side, she there attaches it firmly, by applying her spinners. To the middle of this diagonal thread, which is to form the centre of the net, she fixes a second, which, in like manner, she conveys and fastens to another part of the lines encompassing the area. Along this last-formed thread she returns, drawing out another after her, which, as she does not employ any means to keep it distinct, becomes connected with that on which she is advancing, and is ultimately glued by its extremity to the centre of the net. In this manner, but without observing any regularity in the order of

her progression, she forms about twenty or thirty radii, composed of double lines, diverging from the centre to the circumference, and giving the net the appearance of a wheel. She then proceeds to the centre, turns herself round, and pulls each radius with her feet, to ascertain its strength, breaking such as seem defective, and replacing them by others. Her next proceeding is to produce, round the centre of the net, a spiral line extending thence to the circumference, and intersecting the radii, to which she attaches it by pressing her spinners against them. This spiral line, a few of the more central circumvolutions of which are much nearer to each other than are those removed to a greater distance from that point, serves as a temporary scaffolding for the spider to walk over, and also to keep the radii properly stretched during her succeeding operations. It, together with the radii and marginal lines, is composed of unadhesive silk; but a spiral line has now to be spun, from the circumference around the centre, which may be regarded as constituting the most important part of the snare. It consists of a fine thread, closely studded with minute dew-like globules, easily removable to a greater distance from each other by extending the elastic filament on which they are arranged. They are, in fact, globules of viscid gum, as is proved by their adhering to the finger and retaining dust thrown upon the net, while the unadhesive radii

and exterior threads remain unsoiled. These viscid threads mainly serve to retain the insects which fly into the net; and as they lose their adhesive property by exposure to the air, it is requisite that they should be frequently renewed—a process not neglected by the spider, which evinces a perfect consciousness of its necessity. Placing herself at the circumference of the net, and fastening her viscid thread to the end of one of the radii, the spider walks up that radius towards the centre, till she comes in contact with the last produced circumvolution of the unadhesive spiral line, along which she passes to the adjoining radius, drawing out the thread, in her transit, with the claws of the hind leg nearest to the circumference. She then transfers the thread to the claws of the other hind leg, and passing down the radius at which she has just arrived towards the circumference she places the foot of the hind leg previously employed in drawing out the thread on that point in the radius to which her filament is to be attached, and, bringing the spinners to the spot, there makes it secure. The precise place in each radius at which to fix the thread is always ascertained by the situation of the foot of the hind leg; and this is determined by touching, with the feet of those legs nearest to the circumference, the marginal line, or, when the structure of the net is further advanced, the last-formed circumvolution of the viscid spiral line. As this last

line approaches the several circumvolutions of the unadhesive spiral line, the spider bites them away, being sensible that they are no longer of any use to her; and this fact explains why they are never seen intermixed with the circumvolutions of the former in finished nets. The viscid spiral line, whose circumvolutions are nearly equidistant, being separated by a space varying, according to the size and species of the animal, from about a thirtieth to six or seven tenths of an inch, is thus produced till it extends to the most proximate circumvolutions of the unadhesive spiral line, which, occupying the central part of the net, are suffered to remain; it is then discontinued, and the spider, making choice of some retired spot in the vicinity, there constructs a cell, or selects a situation in which she may conceal herself from observation. From the centre of the net to this retreat she spins a line of communication, composed of several threads united together throughout their entire length, the vibrations of which speedily inform her of the capture of her prey; and here her labours terminate.

Such is the process, with some slight modifications now to be noticed, employed by the Geometric Spiders in the formation of their snares. One species, the *Epeïra calophylla* of M. Walckenaer, generally converts a radius into a line of communication between the net and its retreat, instead of spinning a separate line for that purpose; and this peculiar

appropriation, whether the radius be in the plane of the snare, or whether it be withdrawn from that plane, as is frequently the case, imparts an unfinished appearance to the net, as it prevents the spider from giving her viscid line a spiral form, though this is sometimes attempted with a greater or less degree of success. No sooner does the spider arrive at one of the radii adjacent to that in connexion with her cell, than she returns, traversing the framework of her snare till she arrives at the proximate radius on the opposite side, when she again retraces her steps, and, thus oscillating between the two, spins a number of curved, viscid lines, or arcs of circles, diminishing in length from the circumference of the net towards the centre. Dr. Lister, who has figured and described this species in his treatise 'De Araneis,' fig. x. pp. 47 & 48, was well acquainted with this peculiarity, so common in the structure of its snare; but he has fallen into the error of supposing that it occurs invariably, as appears from the following passage, cited from his work:—"Rete amplum & elegantissimum tendit: illud autem in eo perpetuum & singulare est, nimirùm è radiis unicum *maculis utrinque nudari*, ídque è centro reticuli ad ejus usque circumferentiam; qui ferè ad aliquam in pariete rimulam aut alibi, ubi animal tutò totum diem latet, porrigitur: atque hic radius ei velut scala est, per quem ascendat descendatque."

The learned authors of the 'Introduction to En-

tomology,' in treating upon the construction of the nets of Geometric Spiders (for their remarks, though limited to the proceedings of an individual for the convenience of description, seem to be intended to apply to all), state that the spider always leaves a vacant interval round the smallest, first-spun circles which are nearest to the centre, but for what purpose they are unable to conjecture; and that, lastly, she bites away the small cotton-like tuft which united all the radii at the centre of the net, and in the circular opening resulting from this procedure she takes her station and watches for her prey. In this account I recognize the proceedings of a spider, the *Epeïra inclinata* of Walckenaer, which, as far as my own observations extend, never, like the last species, converts a radius into a line of communication with its retreat; and when it occupies the aperture in the centre of its snare, a thread from its spinners is generally connected with the innermost circumvolution of the unadhesive spiral line, by means of which it quickly lowers itself to the ground when suddenly disturbed. But there are other species which rarely, if ever, leave a vacant interval, of any considerable magnitude, round that portion of the unadhesive spiral line allowed to remain near the centre of the net; neither do they form an opening at the centre, which, almost invariably, is left entire.

The reason why the viscid spiral line is not con-

tinued to the centre of the net is obvious, for by this arrangement the spider is enabled to superintend her toils without incurring the risk of being entangled in them. The species referred to by Messrs. Kirby and Spence as always leaving a vacant interval round the smallest, first-spun circles which are nearest to the centre of her net, produces fewer of those small circles than almost any other Geometric Spider which has fallen under my notice, except the long slender-bodied species, *Tetragnatha extensa*, Latreille, whose economy is very similar; consequently, if the viscid line were prolonged till it made a near approximation to them, the unadhesive lines about the centre would be too closely circumscribed, and the spider would be subjected to great inconvenience.

Hitherto I have supposed the spider to form her snare in places evidently easy of access to her; but it is not unusual to see nets fixed to objects between which it is quite impossible that a communication can have been established by any process alluded to above—between distant plants, for example, growing in water. "Here then," as the authors of the 'Introduction to Entomology' observe, "a difficulty occurs. How does the spider contrive to extend her main line, which is often many feet in length, across inaccessible openings of this description?" To this curious fact my attention has long been directed, and I have

thoroughly satisfied myself, by observation and experiment, that in such instances spiders invariably avail themselves of currents of air, by which their lines are sometimes conveyed to a surprising distance.

If the Geometric Spiders be placed on twigs or metallic rods set upright in glazed earthenware vessels with perpendicular sides, containing a sufficient quantity of water completely to immerse their bases, the spiders, thus insulated, use every means in their power to effect an escape; all their efforts, however, uniformly prove unavailing in a still atmosphere; nevertheless, when exposed to a current of air, or when gently blown upon with the breath, they immediately turn the abdomen in the direction of the breeze, and emit from the spinning-apparatus some of their liquid gum, which, being carried out in a line by the current, becomes connected with some object in the vicinity. This the spider ascertains by pulling it with her feet, and, drawing it in till it is sufficiently tense, she gums it fast to the twig or rod, and, passing along it, speedily regains her liberty. Now, that the same means are frequently resorted to by spiders in their natural haunts, for the purposes of changing their situation and fixing the foundations of their snares, I have repeatedly observed. I am aware that, in the 'Introduction to Entomology,' an objection has been urged against the explanation of the difficulty here insisted upon.

"If," say the learned authors, "the position of the main line be thus determined by the accidental influence of the wind, we might expect to see these nets arranged with great irregularity, and crossing each other in every direction; yet it is the fact that, however closely crowded they may be, they constantly appear to be placed not by accident but design, commonly running parallel with each other at right angles with the points of support, and never interfering." In favourable weather it is well known that the Geometric Spiders frequently begin to construct their nets soon after the close of day; and as similar processes must be influenced in a like manner by the simultaneous operation of the same cause, the lines of individuals carried out by a current of air till they become attached to some distant object will be all parallel or nearly so. This regularity, therefore, instead of militating against the opinion maintained above, appears to me to furnish a powerful argument in support of it.

Sometimes the Geometric Spiders suspend their nets in places not entirely surrounded by objects to which, in the first instance, they can proceed and attach their boundary lines. In such cases their operations are deserving of attention. After spinning a few radii, which are fixed to several distant points most accessible to her, the spider fastens a thread to one of them, gluing it to that extremity which is furthest from the centre of her net. Along this

radius she walks, drawing out the thread after her, and guiding it with one of her hind feet, till she reaches its point of union with one of the adjoining radii: on this radius she steps, and passing along it to the other extremity there makes fast her thread—by this simple process connecting with marginal lines distant objects between which no direct communication previously existed.

In the formation of their nets, spiders are regulated chiefly by the sense of touch, which they possess in high perfection. This is rendered extremely probable by the general tenor of their proceedings; for example, they ascertain when they have the full complement of radii by approaching the centre of the net, which is their common point of union, and touching each in succession with the feet, supplying deficiences wherever they are perceived; and I have already noticed a circumstance which greatly tends to confirm this opinion—namely, that they frequently construct their snares in the night. The fact, however, is established beyond dispute by the following experiment. I have repeatedly confined Geometric Spiders in glass jars placed in situations absolutely impervious to light, and yet, during their captivity, they have produced perfect nets of admirable workmanship.

Spiders were supposed by Dr. Lister * to be able to retract their threads within the abdomen; and

* 'De Araneis,' p. 8.

whoever minutely observes the geometricians when fabricating their silken snares will be almost induced to entertain the same belief. The viscid line produced in the spider's transit from one radius to another is sometimes drawn out to a much greater extent than is necessary to connect the two; yet, on approaching the point at which it is to be attached, it appears rapidly to reenter the spinners, till it is reduced to the exact length required. This optical illusion, for such it is, is occasioned by the extreme elasticity of the thread, which may be extended greatly by the application of a slight force, and, on its removal, will contract proportionally. The viscid line alone possesses this property in an extraordinary degree (the radii and marginal lines being scarcely remarkable for it), by which it is adapted to the frequent and rapid changes in distance that take place among the radii when the net is agitated by winds or other disturbing forces, and by which the insects that fly against it are more completely entangled than they otherwise could be, without doing extensive injury to the framework of the snare.

In order to determine whether objects entangled in their toils are animate or inanimate, the Geometric Spiders pull with their feet the radii immediately in connexion with that part of the snare in which they are suspended, and, suddenly letting go their hold, produce by these means a vibratory motion

in the net, which seldom fails to excite to action such insects as are ensnared. Guided by the struggles of her prey, the spider runs along the most contiguous radius to seize her victim, avoiding any contact with the viscid line as much as possible, and drawing out after her a thread attached to one of the lines near the centre of her net, which serves to facilitate her return.

Complicated in structure, elegant in design, and admirably adapted to effect the purpose for which they are intended, the nets of the Geometric Spiders may, nevertheless, be shown by experiment to result from a propensity to construct inherent in those animals; for when their eggs are hatched in glass jars, apart from every species belonging to the family, the newly disclosed young, acting under the stimulus of hunger, not only fabricate snares, prior to having acquired the slightest knowledge of their prey, but, even in their earliest attempts to accomplish their object, display as consummate skill as the most experienced individuals.

OBSERVATIONS ON THE STRUCTURE AND ECONOMY OF SPIDERS.

Among the various species of *Araneidea* which capture their prey by means of snares composed of the animal secretion emitted from their spinners, it would be difficult to select any, the Geometric Spiders alone excepted, whose structure and economy are better deserving of investigation than those of *Ciniflo atrox*. Whoever inspects closely the snare of this very common species cannot fail to be struck with the singularity of its appearance, and will naturally feel a desire to be made acquainted with the process employed in its formation. Such, at least, has been the case with myself; and I have experienced no small degree of disappointment in not being able to obtain any information on the subject from those authors whose works I have had an opportunity of consulting. This unsuccessful examination of the labours of naturalists, many of them distinguished for the extent of their learning, the minuteness of their researches, and the comprehensiveness of their views, induces me to believe it probable that the inquiry

may not have had that attention bestowed upon it which it undoubtedly merits. As it is one, however, which for some time past has occasionally occupied a portion of my leisure hours, I shall proceed to detail the results of my observations, trusting that if they should not possess that novelty which, notwithstanding my limited knowledge of the writings of foreign zoologists, I am disposed to claim for them, still they will not be found wholly devoid of interest.

The favourite haunts of *Ciniflo atrox* are the branches of trees and shrubs growing against buildings, crevices in old walls, and the corners of windows. In these and similar localities it fixes its residence and fabricates its snare. On the objects surrounding the spot selected for its retreat it extends to a considerable distance, but without any apparent regularity or design, a number of fine, glossy lines intersecting each other at various angles, to which it attaches other lines, or rather fasciculi of filaments, of a complicated structure, and of a pale blue tint, nearly approaching the colour of skimmed milk. These compound filaments, or flocculi, which in exposed situations retain their delicate hue for a short period only (old snares being generally of a dull or sullied white, not at all advantageous to their appearance), are arranged on the first spun glossy lines both in longitudinal and transverse directions. When recently produced they adhere strongly to such insects as come in contact with them, and,

though perfectly inelastic, may be drawn out into fibres of extreme tenuity. A communication between the snare of this spider and its retreat is established by means of a funnel-shaped tube, of a slight texture, whose smaller extremity is in immediate connexion with the latter, and, indeed, sometimes constitutes the animal's abode. Not unfrequently two tubes occur in the same snare, by one or other of which the spider usually effects its retreat when disturbed.

If a newly formed flocculus be minutely examined under the microscope, with a pretty high magnifying-power, it will be found to consist of four lines and two delicate bands. Two of the former are straight and exceedingly attenuated, and upon each of them is disposed a tortuous line, inflected into short curves and loops, like a ravelled thread of fine silk. A pale blue band, distributed on each of the tortuous lines in numerous irregular curvatures, completes the flocculus. The flexures of the pale blue bands are more widely extended than those of the tortuous lines on which they occur, and to them the adherent property of the snare is chiefly to be ascribed. In attempting to determine by experiment the cause of adhesion in the blue bands, I ascertained that bodies with highly polished surfaces, such as the bulbs of thermometers and burnished metallic rods, if carefully applied to them, may be withdrawn without deranging their structure, though the viscid globules in the nets of Geometric Spiders adhere to the same bodies as soon

as they are brought into contact with them. From this circumstance I was led to infer that the blue bands are fibrous, although their structure is so exceedingly fine that I cannot detect it even with the assistance of the microscope, and that the imperceptible filaments of which they are composed adhere to objects, not in consequence of being glutinous, but solely by attaching themselves to inequalities on their surfaces. The following brief description of the manner in which the flocculi are fabricated, and of the curious apparatus employed in the process, gives additional weight to this opinion.

There are on the metatarsi of the posterior legs of *Ciniflo atrox* two parallel rows of fine spines, movable at the will of the animal, which may readily be discerned by means of a lens having a magnifying-power of ten or twelve. They are situated upon a ridge on the abdominal side of the superior surface of the joint, commencing a little below its articulation with the tibia, and terminating at a strong spur near its extremity. The spines composing the upper row have a considerable degree of curvature, and taper gradually to a fine point, those of the lower row being stronger, more closely set, and less curved. This important appendage has received the name of *calamistrum*, and constitutes a striking character, which ought on no account to be omitted in descriptions of *Ciniflo atrox*.

When the spider purposes to form a flocculus, it

presses its spinners (which are eight in number) against one of the glossy lines composing the foundation of its snare, and, emitting from them a small quantity of liquid gum, attaches to it several fine filaments drawn out by advancing the abdomen a little, and kept distinct by a lateral motion of the mammulæ. The posterior legs are then raised above the plane of position, and the foot of one of them is applied to the superior surface of the metatarsal joint of the other, a little above its articulation with the tarsus, and the calamistrum, before described, is brought immediately beneath the spinners, at right angles with the line of the abdomen. By a slight extension of the joints of the posterior legs the calamistrum is directed backwards across the mammulæ, the diverging extremities of which it touches in its transit, and is restored to its former position by a corresponding degree of contraction in the joints. In proportion to the continuation of this process (and it is not at all unusual for the spider to pass the calamistrum across the points of the mammulæ several hundred times in rapid succession), the inflected lines and bands of the flocculus are found to be produced, the spider making room for them as they accumulate by elevating, and at the same time advancing, the abdomen, which it effects by slightly extending the joints of the third pair of legs and contracting those of the first and second pairs. As this operation is generally performed in the night, it

can seldom be seen to advantage unless artificial light be employed, some skill in the management of which is required in order to avoid disturbing the spider. The *modus operandi*, as nearly as I can ascertain it by the most diligent observation, appears to be this. The points of the lower row of spines in passing over the extremities of the mammulæ draw from them lines which run into numerous flexures in consequence of not being kept fully extended ; and the purpose subserved by the upper row of spines seems to be the detachment of these lines from the spines of the lower row by a motion upwards. Now, were the blue bands glutinous, this mode of proceeding would be quite unavailing ; it is only on the supposition, therefore, that they have a fibrous structure that their adherent property can be satisfactorily explained. When a sufficient quantity of the inflected filaments is produced, the spider again applies its spinners to one of the glossy lines, and attaches the flocculus to it. In this manner it proceeds with its labours, occasionally employing both calamistra, till the snare is completed. Should many of the flocculi be destroyed, or rendered almost useless by having their adherent property impaired, new ones are constantly added to the snare.

The admirable adaptation of the structure and disposition of the calamistra to their action on the spinners, by which, under the directing influence of instinct, the curious snare of *Ciniflo atrox* is perfected,

affords manifest evidence of design, and, consequently, of an intelligent designing agent.

A more exact idea of the mechanism of the calamistrum than can be conveyed in words will be obtained by inspecting Plate I. figs. 1 and 2 *.

Distinguished naturalists have represented spiders as having their tarsi armed at the extremity with three claws, which occupy the upper and anterior portion of the foot. That this is the case with many species cannot be denied; other species, however, belonging to various genera (*Mygale avicularia, Clubiona erratica, Drassus nitens, Hecaërge spinimana, Philodromus dispar*, and *Salticus scenicus*, for example), have only *two claws* on each foot; and if the tarsi of the larger Geometric Spiders indigenous to Great Britain, such as *Epeïra umbratica, Epeïra quadrata, Epeïra diadema*, and *Epeïra apoclisa*, be examined under the microscope with a highly magnifying-power, it will be distinctly perceived that the inferior part of their feet is provided with several claws, which have a considerable degree of curvature, are finely pointed, and are furnished with tooth-like processes on the underside (Plate I. fig. 3); and should the investiga-

* The calamistrum of some small spiders belonging to the genera *Ergatis, Mithras*, &c. consists only of a single row of curved, movable bristles; and the proximate extremities of their additional or fourth pair of spinners, unlike those of the larger species of the genus *Ciniflo*, are not separated by a septum, but are usually without any definite mark of distinction.

tion be extended to other retiary spiders, the feet of many species which construct complicated snares will likewise be found to exhibit a similar organization. As the best means of guarding against errors, to which the inspection of limbs defective in structure might conduce, it is advisable to select the legs of vigorous individuals which have recently moulted whenever such can be procured.

The supernumerary claws were first observed by me in examining the feet of *Epeïra apoclisa*; and in every instance I counted as many as five, which, with the three upper ones previously known, give a total of *eight claws* on the same foot, distinguishable at a glance from the coarse, setaceous hairs in their vicinity. There is also a strong, movable spine inserted near the termination of the tarsus of each posterior leg on the underside, which curves a little upwards at its extremity, and exhibits a slight irregularity of outline at its superior surface. The function performed by these spines, which have been named *sustentacula*, is an important one. By the contraction of their flexor muscles they are drawn towards the foot, and are thus brought in immediate opposition to the claws, by which means the animal is enabled to hold with a firm grasp such lines as it has occasion to draw from the spinners with the feet of the hind legs, and such also as it designs to attach itself to. Now, as the sustentacula and the spinning-apparatus are the most efficient instruments employed by the

Geometric Spiders for the purpose of suspension, it is obvious why they usually direct their heads downwards when they occupy the centre of their nets.

As several difficulties present themselves in the prosecution of these researches, occasioned, chiefly, by the impracticability of comprising all the claws in one distinct view, I cannot completely satisfy myself, at present, whether the number and arrangement of the additional claws are uniformly the same, on the feet of such spiders as I have ascertained to be supplied with them, or not; though, as regards the larger species, I am thoroughly convinced that this is the case, and I have reason to think that it will ultimately prove to be so with the rest.

It is not at all surprising that the Geometric Spiders, which employ their feet in the fabrication of complicated nets, should have them more amply provided with claws than those species which use theirs principally as instruments of progression. An estimate of the number of viscid globules distributed on the elastic spiral line in a net of *Epeïra apoclisa* of a medium size will convey some idea of the elaborate operations performed by the Geometric Spiders in the construction of their snares. The mean distance between two contiguous radii in a net of this species is about seven tenths of an inch; if, therefore, the number 7 be multiplied by 20, the mean number of viscid globules which occur on one tenth

of an inch of the elastic spiral line, at the ordinary degree of tension, the product will be 140, the mean number of globules deposited on seven tenths of an inch of the elastic spiral line; this product multiplied by 24, the mean number of circumvolutions formed by the elastic spiral line, gives 3,360, the mean number of globules contained between two radii; which multiplied by 26, the mean number of radii, produces 87,360, the total number of viscid globules in a finished net of average dimensions. A large net, fourteen or sixteen inches in diameter, I have found, by a similar calculation, to contain upwards of 120,000 viscid globules; and yet *Epeïra apoclisa* will complete its snare in about forty minutes, on an average, if it meet with no interruption. Astonishingly great as this number of globules is, each is separated from those adjacent to it by a sensible space: indeed the material of which they are composed is so fluid, that they run together the moment they are brought into contact. The globules and the intervals between them may be distinctly seen with the assistance of a magnifier of the power of ten; and it would appear from the following passage, extracted from 'Micrographia,' p. 202, that they did not escape the notice of Dr. Hooke:—"I observed further," he informs us, "that the radiating chords of the web were much bigger and smoother than those that were woven round, which seemed smaller, and all over knotted or pearled with small transparent glo-

bules, not unlike small crystal beads or seed pearls thin strung on a clew of silk; which, whether they were so spun by the spider, or by the adventitious moisture of a fog (which I have observed to cover all these filaments with such crystalline beads), I will not now dispute."

Messrs. Kirby and Spence, in their 'Introduction to Entomology,' vol. i. letter xiii., state, that "the net of the Garden Spider is composed of two distinct kinds of silk; that of the radii not adhesive, that of the circles extremely viscid:" and this difference, they remark, "when it is considered that both sorts proceed from the same instrument, is truly wonderful." The fact, however, is even more extraordinary than it is represented to be by those distinguished naturalists; for not only the Garden Spider, but every Geometric species with which I am acquainted employs *three* distinct kinds of silk, if a liquid gum can with propriety be termed silk, in the construction of its net. The boundary lines, radii, and first formed spiral line being unadhesive, and possessing only a moderate share of elasticity, are evidently composed of a different material from the last formed spiral line, which is exceedingly viscid and elastic in a remarkable degree. Now the viscidity of the elastic spiral line may be shown to depend entirely upon the globules with which it is studded; for if they be removed by careful applications of the finger, a fine glossy line remains, which is highly elastic, but perfectly unadhe-

sive. As the globules, therefore, and the line on which they are disposed differ so essentially from each other and from the rest of the snare, it is reasonable to infer that the physical constitution of these several portions of the net must be dissimilar. The silk of which the cocoons and cells of many spiders are constructed also differs remarkably in strength and colour from that which enters into the composition of their snares.

When exposed to the desiccating influence of the sun, and of air briskly agitated, the nets of Geometric Spiders speedily lose their adhesive property; but when formed in situations from which light is excluded, and where the atmosphere is not liable to be perceptibly disturbed, I have known them retain their viscidity for a long period. In a net of *Epeïra diadema* constructed in a glass jar, which was placed in a dark closet, where the temperature was not subject to great or sudden fluctuations, the globules preserved their adhesive power, almost unimpaired, and the last formed spiral line its elasticity, for more than seven months.

The belief that spiders are incapable of ascending the perpendicular surfaces of polished bodies without the assistance of lines emitted from their spinners is so widely extended, that an attempt to prove its fallacy in particular cases will, in all probability, be received with some distrust: nevertheless the fact that many species have the power of traversing vertical

panes of window-glass in any direction whatever, unsupported by a single filament, may be easily confirmed by experiment. Among the British Spiders observed to ascend with facility well-cleansed windows and the sides of glass jars in which they have been confined, I may name *Clubiona accentuata*, *Drassus nitens*, *Hecaërge spinimana*, *Philodromus dispar*, and *Salticus scenicus*. The last species is extensively known, and may be readily procured in warm sunny weather in summer, on the walls of old buildings having a southern aspect.

On examining the legs of these animals under the microscope, with a view to discover the means by which they support themselves in opposition to gravity, I perceived that the tarsi are provided on the underside with numerous appendages curving downwards, which are slender at their base and dilated towards their extremity (see Plate I. fig. 4). The idea immediately occurred to me that these appendages may perform the office of suckers, and that the spiders are probably enabled to adhere to the upright sides of smooth objects by atmospherical pressure; but being sensible that mere conjecture, however plausible it may appear, is the bane of natural history, I resolved to investigate the subject experimentally. Having obtained spiders of the above-named species in various stages of growth, I found that the larger individuals experienced greater difficulty in ascending glass than the smaller ones, which, in numerous instances,

were capable of moving on an ordinary window-pane, even in an inverted position, or with the back downwards. It was evident also that physical energy (other conditions being the same) gave its possessor a decided advantage in this respect. When highly polished glass of a superior quality was employed, the difficulty was somewhat increased; and, in all cases, those spiders effected an ascent with the greatest effort which, in proportion to their bulk, had the inferior surface of their tarsi most sparingly furnished with the requisite apparatus. These results, some of which are in direct opposition to the hypothesis I had previously entertained, determined me to inspect the tarsal appendages more minutely than I had hitherto done; and a peculiarly favourable opportunity unexpectedly presented itself. Three living specimens of *Mygale avicularia* having been brought accidentally to Manchester, in dye-woods imported from the West-India Islands during the year 1830, I availed myself of the circumstance to examine under the microscope the appendages with which the tarsi of that gigantic species are so abundantly supplied, conceiving that their structure would be exhibited to greater advantage in a recent subject than in individuals which have long occupied a place in the cabinet. In this expectation I was not disappointed; and I shall now proceed to describe the organization of the appendages, which is much more complex than I had anticipated. Each consists of a

slender shaft fringed on the sides with exceedingly fine hairs gradually diminishing in length as they approach its extremity, which is provided on its inferior surface with a profusion of hair-like papillæ, forming a dense brush, and giving the part that dilated appearance already alluded to. This structure, somewhat modified, as far as my researches extend, is common to the tarsal appendages of those spiders which are able to ascend the perpendicular sides of smooth bodies without supervenient aid; and the minute papillæ with which the tarsal cushions of many insects remarkable for their ability to walk up glass are furnished, appear to possess an organization closely analogous.

The hold upon objects which the hair-like papillæ give to the spiders provided with them, depending, in a great measure, on the numerous points of contact they present, seems to be mechanical; nevertheless, it has been shown by experiment (see pp. 222 & 223) that their efficiency in this respect must be attributed, principally, to a viscous secretion which they emit. At a moderate estimate, there are on the appendages which form the brushes occurring on the inferior part of the metatarsi and tarsi and the digital joint of the pediform palpi of adult females of the species *Mygale avicularia* more than 4,000,000 papillæ of extreme delicacy, a large proportion of which can be applied by the spider to bodies with plain surfaces. If the finger be drawn

gently along the underside of the tarsi, from their extremities towards the tibiæ, they will be found, even in dried specimens, to adhere powerfully to the cuticle, the sensation occasioned by this proceeding exciting in the mind the idea that they are smeared with some viscous matter. At Plate I. an appendage from one of the tarsal brushes of *Mygale avicularia* is represented by fig. 5, and one of the compound hairs which clothe the limbs of *Tegenaria civilis* by fig. 6. It is almost unnecessary to offer any caution against confounding objects so essentially distinct.

Dr. Leach, in treating upon spiders in the article "Annulosa," published in the Supplement to the 'Encyclopædia Britannica,' p. 435, remarks that "when about to cast their covering, they suspend themselves in some corner, and creep out of a crack which takes place on their back, gradually withdrawing their legs from the skin, as if from a glove." With deference to so accomplished a zoologist, I may be allowed to observe that this statement is not in strict accordance with my own experience; and as I do not remember to have met with a satisfactory account of the moulting of spiders, in the course of my reading, I shall endeavour to elucidate this curious subject by giving such particulars relative to it as have fallen under my notice.

Considering the apparent uniformity of the process by which this important change in the external con-

dition of spiders is effected, it will suffice to detail the proceedings of a single species; and as *Epeïra calophylla* is of frequent occurrence about retired buildings situated in the country, and, consequently, may be procured without difficulty, I shall select it for the purpose. Preparatory to casting its integument, this spider spins several strong lines in the vicinity of its snare, from which it suspends itself by the feet and a filament proceeding from the spinners. After remaining for a short time in this situation, the coriaceous covering of the cephalothorax gives way,—not in the median line of the dorsal region, as Dr. Leach's statement would seem to imply, but laterally, disuniting immediately above the insertion of the falces and legs, so that the head and thorax are the first parts liberated. The line of separation pursues the same direction till it extends to the abdomen, which is next disengaged, the extrication of the legs being the last and greatest difficulty which the spider has to overcome. As the suspensory filament connected with the spinners of the exuviæ is considerably shorter than the legs, and does not undergo any sensible alteration in length, the abdomen, during the process of moulting, becomes gradually deflected from its original horizontal direction till it assumes a vertical position, nearly at right angles with the cephalothorax. By this change of posture, attended with numerous contortions of the body, and alternate contractions and extensions

of the limbs, the spider is ultimately enabled to accomplish its purpose. The spines with which the legs are provided no doubt contribute greatly to facilitate the operation; for, as they are directed down the limbs, and are movable at the will of the animal, when it has partially withdrawn the legs from their sheaths by contracting them, it can prevent them from reentering by slightly erecting the spines, and thus bringing their extremities in contact with the inner surface of the integument. When the spider has completely disengaged itself from the slough, it remains, for a short period, in a state of great exhaustion, suspended solely by a thread from the spinners connected with the interior of the abdominal portion of the cast skin, which is much corrugated and drawn together. The entire process, as above described, occupies the space of about twenty minutes. After reposing a little, the spider further attaches itself to the suspensory lines by the claws of the feet; and when its strength is sufficiently restored, and its limbs have acquired the requisite degree of firmness, it ascends its filaments and seeks its retreat.

Having frequently witnessed the moulting of spiders in their natural haunts, and also in a state of captivity, and having carefully examined the cast skins of numerous species belonging to the genera *Dysdera*, *Segestria*, *Clubiona*, *Drassus*, *Tegenaria*, *Textrix*, *Theridion*, *Neriene*, *Pachygnatha*, *Linyphia*,

Epeïra, Thomisus, Dolomedes, Lycosa, Hecaërge, Salticus, &c., in the precise situations, and under the same circumstances, apparently, in which they have been left by their former occupiers, I am thoroughly persuaded that the process is a very uniform one.

Recent observations establish the fact that the number of times spiders change their integument before they become adult is not uniformly the same as regards every species. A young female *Epeïra calophylla*, disengaged from the egg on the 30th of March, 1843, moulted on the 8th of the ensuing month in the cocoon, which it quitted on the 1st of May, moulting again, in the same year, on the 4th of June, the 22nd of June, the 12th of July, and the 4th of August, respectively, when it arrived at maturity, having cast its skin five times.

An egg of *Epeïra diadema* hatched on the 14th of April, 1843, produced a female spider, which moulted in the cocoon on the 24th of the same month; on the 3rd of May it quitted the cocoon, and moulted again on the 21st of June, the 10th of July, the 3rd of August, and the 23rd of August, in the same year. On the 28th of February, 1844, it died in a state of immaturity after having completed its fifth moult.

On the 27th of June, 1842, an egg of *Tegenaria civilis* produced a female spider, which underwent its first moult in the cocoon on the 10th of the ensuing July: quitting the cocoon on the 21st of

the same month, it moulted again on the 17th of August, the 4th of September, and the 26th of September in the same year, and on the 26th of January, the 9th of April, the 24th of May, the 21st of June, and the 5th of August in 1843, when it arrived at maturity, having changed its integument nine times.

A male *Tegenaria civilis*, extricated from the egg on the 27th of June, 1842, also moulted nine times, casting its skin in the cocoon on the 10th of the following July; on the 21st of the same month it abandoned the cocoon, moulting again on the 13th of August, the 10th of September, and the 13th of October in the same year, and on the 1st of February, the 25th of April, the 17th of June, the 13th of July, and the 17th of October in 1843, when its development was complete.

Modifications of food and temperature exercise a decided influence upon the moulting of spiders. A young female *Tegenaria civilis* disengaged from the egg on the 24th of July, 1842, on the 2nd of the following August moulted in the cocoon, which it quitted on the 12th of the same month, casting its skin again on the 29th of August and the 10th of October in the same year; being scantily supplied with nutriment, it increased very little in size, and died on the 4th of July, 1843, having changed its integument three times only. Another female of the same species, which was extricated from the egg on

the same day as the foregoing individual, and was well fed, on the 13th of July, 1843, had moulted seven times. It is apparent also, from the particulars already stated, that the intervals between consecutive moults are much shorter when the temperature of the atmosphere is high than when it is low.

Immature spiders infested by the larva of *Polysphincta carbonaria*, an insect belonging to the family *Ichneumonidæ*, which feeds on their fluids, never change their integument.

Intimately connected with the renovation of the integuments is the reproduction of the limbs of spiders. For this interesting discovery we are indebted to the late Dr. C. Heineken, whose investigations relative to the subject are published in the 'Zoological Journal,' vol. iv. pp. 284 & 422; and I am happy to bear testimony to the general accuracy of his conclusions.

The reproduction of the palpi and spinners does not appear to have been noticed by Dr. Heineken; but that those members, after suffering mutilation, are restored in the same manner as the legs, I have proved by repeated experiments. That mutilated members are not always reproduced at a subsequent moulting, even when it takes place at a period considerably after the infliction of the injury, is rendered evident by the following remarkable fact. On the 13th of July, 1830, a male specimen of *Ciniflo atrox* had the palpus and the second leg

on the right side divided, the former near the base of the humeral joint, the latter about the middle of the femur, and on the 15th of the succeeding month it cast its skin; yet, though all the other limbs were renewed, the stumps only of the mutilated members were reproduced. In cases in which spiders spontaneously throw off their legs at the articulation of the femur with the coxa, or have them partially removed by amputation, it would be desirable to ascertain in what state the limbs to be reproduced exist just previously to the act of moulting, as there is something mysterious in their extraordinary development during that process.

I have since clearly established by dissection the fact that reproduced legs, immediately antecedent to the process of moulting, are curiously folded in the integument of the undetached portion of such mutilated members.

The dimensions of reproduced limbs are in inverse ratio to the extent of the injury previously inflicted on the parts; thus palpi and legs detached at the axillary joint and coxa are usually symmetrical, but diminutive, when reproduced; while those amputated at the articulation of the digital with the radial joint, and near the middle of the tibia or the metatarsus, on being restored, are always very much larger and unsymmetrical: in point of fact, the development of the new limb depends upon the capacity of the unde-

tached portion of the mutilated part; for if a leg be amputated near the middle of the metatarsus, the coxa, femur, and tibia will be of the same dimensions as those joints of the corresponding leg on the opposite side, but the metatarsus and tarsus will be very diminutive; should the excision be made near the anterior extremity of the tibia, then the size of the coxa, femur, and genual joint will be normal, but that of the tibia, metatarsus, and tarsus will be very abnormal. These curious results plainly demonstrate that not only reproduced limbs in their totality, but that particular joints also are limited in their dimensions by the capacity of the undetached portion of the mutilated part in which they are developed, and that restored legs and palpi are never symmetrical except when developed in the undetached coxa and axillary joint respectively.

In order to obtain a satisfactory explanation of the phenomena stated above, it must be conceded that the limbs of spiders produced at each successive moult, from the period at which the animals quit the cocoon till they arrive at maturity, are absolutely new organs resulting from the vital functions of assimilation and accretion; indeed the renewal of a repeatedly detached leg at each succeeding change of integument, and the circumstance of the dimensions of entire limbs or portions of limbs depending upon the space allowed for their development at the time of restoration, present difficulties which do not admit

of a solution on any other physiological principle that I am aware of.

For some years past I have been engaged, occasionally, in conducting experiments having for their object the determination of a highly interesting question in physiology—namely, what are the true nature and functions of the remarkable organs connected with the digital or terminal joint of the palpi of male spiders? The opinion advanced by M. Treviranus, and adopted by M. Savigny, that those parts are instruments employed for the purpose of excitation merely, preparatory to the actual union of the sexes by means of appropriate organs situated near the anterior extremity of the inferior region of the abdomen, is in direct opposition to the views of Dr. Lister and the earlier systematic writers on arachnology, who regarded them as strictly sexual; and the results of my own researches, which I shall proceed to detail, clearly demonstrate the accuracy of the conclusions arrived at by our celebrated countryman.

In the spring of 1831 I procured young female spiders of the following species:—*Epeïra diadema*, *Epeïra apoclisa*, *Epeïra calophylla*, *Epeïra cucurbitina*, *Theridion nervosum*, *Theridion denticulatum*, *Agelena labyrinthica*, &c., and having placed them in glass jars, I fed them with insects till they had completed their moulting and arrived at maturity, which is easily ascertained, in most instances, by the perfect development of the sexual organs. I then introduced to

them adult males, taking care to remove the latter as soon as a connexion had been consummated in the usual manner, by the application of the palpal organs to the orifice situated between the branchial opercula in the females. I never, in a single instance, suffered the sexes to remain together any longer than I found it convenient to continue my observations; and I may remark that their union, however prolonged and undisturbed, was invariably accomplished in the manner stated above, without the slightest deviation being perceptible on the most minute inspection. After a lapse of several weeks, the females, thus impregnated, respectively fabricated their cocoons and deposited their eggs in them, all of which proved to be prolific, affording a complete refutation of the opinion promulgated by M. Treviranus.

In the act of copulation, the extremity of the organ of each palpus of the male, in a state of tumefaction, is usually introduced alternately into the vulva of the female, and that many times in succession, without being once brought into contact with any part of its own abdomen, though it is very frequently conveyed to the mouth; and I have observed a male *Lycosa lugubris* apply its right palpus eighty times, in the manner above described, to the vulva of a female (both of which had been placed in a clean glass phial), without the possibility of bringing it into contact with the inferior surface of its abdomen, except by a very conspicuous change of position; and as an equal

number of similar acts were performed by the left palpus, we have the extraordinary fact of the palpal organs being employed 160 times during this greatly protracted process, unaccompanied by any contact whatever with the part where the seminal ducts are considered to terminate.

A male *Agelena labyrinthica*, confined in a phial, spun a small web, and among the lines of which it was composed I perceived that a drop of white milk-like fluid was suspended: how it had been deposited there I cannot explain; but I observed that the spider, by the alternate application of its palpal organs, speedily imbibed the whole of it. Perhaps the only safe conclusion to be drawn from this very remarkable circumstance, taken in connexion with the previously well-ascertained office of these parts, is that it affords a complete answer in the affirmative to a question asked by M. Dugès, namely, "le conjoncture" (palpal organ) "ferait-il alternativement l'office de siphon absorbant et d'organe éjaculateur?"

Having repeated the foregoing experiment with numerous species of spiders, and the results obtained being uniformly the same, there did not appear to be any necessity for pursuing the investigation further; nevertheless, that there might not remain the slightest doubt on the mind of the most fastidious inquirer, in the summer of 1832 I brought up from the egg young females of the species *Epeïra calophylla*, which, when they had arrived at maturity, I treated in the

manner described in the preceding cases. In the autumn of the same year these spiders deposited their eggs in cocoons spun for their reception, out of which the young issued in the ensuing spring, having undergone their first moult in the cocoons.

These experiments, besides effecting the purpose for which they were instituted, served also to supply collateral evidence of the correctness of M. Audebert's observations relative to the capability of the House-spider (*Tegenaria domestica*) to produce several sets of prolific eggs in succession without renewing its intercourse with the male; for three females of the species *Agelena labyrinthica* deposited each a second set of eggs, and a female *Epeïra cucurbitina* laid four consecutive sets, intervals of fifteen or sixteen days intervening, all of which produced young, though these females had not associated with males of their species for a considerable period antecedent to the deposition of the first set of eggs *.

Female spiders, though incapable of producing pro-

* These results have been confirmed by subsequent researches, which have also served to prove that the female of *Tegenaria civilis*, when impregnated, is capable of producing many sets of prolific eggs in succession without further sexual intercourse, two years or more occasionally elapsing before all are deposited, and a period of ten months nearly intervening sometimes between the deposition of two consecutive sets. (See the Report of the Fourteenth Meeting of the British Association for the Advancement of Science, held at York in 1844, Reports on the State of Science, pp. 68 & 69).

lific eggs without sexual intercourse, nevertheless, when thus circumstanced, do occasionally produce eggs that are sterile.

Four, six, or eight mammulæ, somewhat conical or cylindrical in figure, and composed of one or more joints each, constitute the external spinning-apparatus of the *Araneidea* : they are usually closely grouped in pairs at the extremity of the abdomen, and are readily distinguished from each other by their relative positions. The pair situated nearest to the anus may be denominated the superior spinners; the pair furthest removed from the anus the inferior spinners; and the mammulæ placed between these extremes the intermediate spinners, distinguishing them, when there are two pairs, by prefixing the terms superior and inferior. Exceedingly fine movable papillæ or spinning-tubes, for the most part dilated at the base, occur at the extremity of the mammulæ, or are disposed along the inferior surface of their terminal joint, whence issues the viscous secretion of which all the silken lines produced by spiders are formed. The papillæ connected with the mammulæ vary greatly in number in different species of spiders, and also differ considerably in size, not only in individuals of the same species, but often even on the same mammulæ.

Among our native spiders, the larger species of *Epeïra* have the mammulæ most amply provided with papillæ; it is certain, however, that the total number

does not greatly exceed a thousand even in adult females of *Epeïra quadrata*, whose weight is about twenty grains, and in many other species it is much smaller. In *Tegenaria civilis* the total number of papillæ does not amount to four hundred; in *Textrix lycosina* and *Clubiona corticalis* it is below three hundred, in *Segestria senoculata* it scarcely exceeds one hundred, and in many of the smaller spiders it is still further reduced.

A difference in the number and size of the papillæ connected with the several pairs of mammulæ in the same species, and with similar pairs in different species, is also very apparent. In spiders of the genera *Epeïra*, *Tetragnatha*, *Linyphia*, *Theridion*, and *Segestria* they are generally much more numerous and minute on the inferior spinners than on the superior and intermediate ones; the last are the most sparingly supplied with them, and in the case of *Segestria senoculata* each has only three large papillæ at its extremity. An arrangement nearly the reverse of this takes place in some of the *Drassi*, and is conspicuous in *Drassus ater*, which has the intermediate spinners abundantly furnished with papillæ, those on the inferior spinners being very few in number and chiefly of large dimensions, emitting the viscous secretion copiously. The papillæ connected with the short terminal joint of each inferior spinner of this species vary in number with the age of the animal: the young, on quitting the cocoon, are provided with

four only; individuals which have attained nearly a third of their growth have five or six; those about two-thirds grown six or seven; and adults, which have acquired their full compliment, eight—two of them, situated on the inferior surface of the spinner, at a greater distance from its extremity than the rest, are minute and almost contiguous. It is a fact deserving of notice that the papillæ are not always developed simultaneously on these spinners, six, seven, or eight being sometimes observed on one, when five, six, or seven only are to be seen on the other; and this remark is applicable not to the inferior spinners alone, but to the intermediate ones also, which, in mature individuals, are further modified by having the extremities of the terminal joints directed downwards at right angles to their bases. The same law of development holds good as regards the papillæ connected with the inferior spinners of *Drassus cupreus* and *Drassus sericeus*; and though their number is not uniformly the same even in adults of either of these or the preceding species, yet the two minute ones belonging to each mammula are present invariably.

One of the most striking peculiarities in the structure of the *Ciniflonidæ* is the possession of a fourth pair of spinners. These spinners are shorter and further removed from the anus than the rest, being situated at the base of the inferior intermediate pair, by which they are almost concealed when in a state

of repose. Their figure is somewhat conical, but compressed and truncated, so that the base and apex are elliptical with long transverse axes. Consisting of a single joint only, each is connected with the other throughout its entire length, the extremity alone being densely covered with exceedingly minute papillæ, which emit the viscous matter that is formed by the *calamistra* into the delicate tortuous bands constituting a portion of every flocculus in the snares of the larger *Ciniflones*, and chiefly imparting to them their most important property, that of adhesion (see Plate II. fig. 1).

A small conical hairy process resembling a mammula, on which, however, I cannot discern any papillæ, occurs at the base of the inferior spinners of various spiders belonging to different genera.

MM. Lyonnet and Treviranus, with other skilful zootomists, have fallen into the error of mistaking the superior spinning-mammulæ of spiders, when triarticulate and considerably elongated, for anal palpi (palpes de l'anus), denying that they perform the office of spinners, in consequence of their having failed to detect the papillæ from which the silk proceeds; and in this opinion they are followed by some arachnologists of the present day. I am inclined to attribute this singular oversight to the peculiar disposition and structure which the papillæ or spinning-tubes connected with the superior mammulæ, when greatly elongated, frequently ex-

hibit. Arranged along the underside of the terminal joint, they present the appearance of fine hairs dilated at the base projecting from it at right angles; but if the spinners, when they are in operation, be carefully examined with a powerful magnifier, the function of the hair-like tubes may be ascertained without difficulty, as the fine lines of silk proceeding from them will be distinctly perceived.

In conducting this observation I usually employ the *Agelena labyrinthica* of M. Walckenaer—partly because I can procure specimens with facility; but chiefly on account of its size, the length of its superior mammulæ, and its habits of industry, affording a combination of advantages comprised by no other British spider (see Plate II. fig. 2).

The purpose subserved by the superior mammulæ, when very prominent and composed of several joints, is the binding down with transverse lines, distributed by means of an extensive lateral motion, the threads emitted from the inferior mammulæ; by which process a compact tissue is speedily fabricated.

The foregoing facts supply a striking exemplification of the importance of connecting physiological investigations with anatomical details.

Not being aware, apparently, of the publication of the discovery in the 'Report of the Third Meeting of the British Association for the Advancement of Science, held at Cambridge in 1833,' p. 445, Baron Walckenaer, in the supplement to the second volume

of his 'Histoire Naturelle des Insectes Aptères,' p. 407, has ascribed it to M. Dugès, whose observations on the subject, in the 'Annales des Sciences Naturelles,' seconde série, t. vi., Zoologie, p. 166, were not published till 1836.

Spiders usually have the groove which is situated on the inner surface of the basal joint of the falces, and receives the terminal joint, or fang, when in a state of repose, armed on each side, to a greater or less extent, with conical, pointed processes, which, by a figure of speech, are commonly denominated teeth; but that they are not the homologues of true teeth is rendered sufficiently evident by the fact that the falces do not constitute any part of the oral apparatus, being lethal instruments employed by the Araneidea in seizing, killing, and compressing their prey.

Eminent arachnologists have stated that the species belonging to extensive divisions of the family *Mygalidæ* are entirely destitute of tooth-like processes on the basal joint of the falces; but the fallacy of this opinion may be easily detected by a careful inspection of specimens taken from the genus *Mygale*, the most typical division of the family. In confirmation of the fact that many of the *Mygalidæ* are provided with a longitudinal row of tooth-like processes, situated between two dense fringes of long, curved, red hairs on the inferior surface of the basal joint of their falces, various examples might be adduced; but it will suffice

on the present occasion to name the *Mygale ursina* of Koch, the *Mygale zebra* of Walckenaer, and the *Atypus Sulzeri* of Latreille.

Near the extremity of the outer margin of the maxillæ of numerous species of spiders there is a slight dark-coloured ridge, surmounted by a series of extremely minute close-set spines, which I have long known and regarded as contributing to give firmness to the most exposed part of those organs, and as affording some assistance in restraining the action and in the retention of the insects on which such spiders prey. Miss Staveley, on examining this structure under a high degree of magnifying-power, has arrived at the conclusion that it may be resolved into a row of minute teeth (Ann. & Mag. Nat. Hist. ser. 3. vol. xvii. p. 399)—an opinion which its connexion with the maxillæ would probably tend to suggest; by its position and conformation, however, it appears to be little, if at all, adapted to aid in the office of mastication.

As the maxillæ of those species of the family *Mygalidæ* that have the palpi articulated at or near their extremity might be expected to present other modifications of structure, it became an object of some interest to subject them to a careful examination; with this view, I dissected several specimens of the *Mygalidæ*, belonging to different genera, from which I obtained the following results:—In no instance was any appearance of a ridge provided with a series of

minute close-set spines observed near the extremity of the outer margin of the maxillæ; but *Mygale ursina*, *Mygale avicularia*, and *Cteniza nidulans* were found to have that deficiency amply compensated by short, distinct, black spines, grouped, apparently without order, on the inferior surface of the base of those organs, towards their inner margin, and to have the apex of the lip also provided with similar spines (see Plate II. figs. 3 & 4). *Mygale zebra* has spines at the base of the maxillæ, but none at the extremity of the lip; and *Atypus Sulzeri*, which has the palpi inserted near the base of the maxillæ, on the outer side, is provided with numerous short spines on the inferior surface of those organs, towards the inner margin, but is without any either at their base or at the apex of the lip.

I have hesitated to apply the term teeth to the conspicuous spines at the base and towards the inner margin of the inferior surface of the maxillæ and at the apex of the lip of certain species of the family *Mygalidæ*, notwithstanding that they are employed by them in retaining and also, to some extent, in lacerating their prey; but to a remarkable group of spines, situated on the superior surface of the maxillæ of *Mygale zebra*, and clearly indicating, by its position and structure, that the principal function it performs must be that of mastication, the appellation of teeth appears to be more appropriate (see Plate II. fig. 5). The spines composing this group, which are of a

dark-brown colour, and have their pointed extremity directed towards the inner margin of the maxillæ, are fewer in number, enlarged at the extremity, and much longer and more distinct near the posterior end of each group than the closely compacted ones that form its anterior part. These spines, by their figure and arrangement, present a highly interesting subject for inspection under the microscope.

From the foregoing observations it is evident that much careful investigation is yet required to complete our knowledge of the various minute appendages connected with the external organs of Spiders and of the purposes to which they are subservient.

In attempting to drown a small Spider named *Neriëne longipalpis,* for the purpose of taking its dimensions accurately by measurement, I was astonished to find that at the expiration of two days, though it had remained under water the whole of the time, it was as lively and vigorous as ever. This extraordinary circumstance induced me to submerge numerous specimens, of both sexes, in cold water contained in a glass vessel with perpendicular sides, on the 21st of October, 1832, in which situation some of them continued for many days without having their vital energies suspended.

This experiment I have tried with other minute species, and several of them have preserved an active state of existence for six, nine, and fourteen days, spinning their lines and exercising their functions as

if in air; while others have not survived for a single hour. It is evident, therefore, from these curious facts, that some Spiders possess the power of extracting respirable air from water; for though, in the act of submersion, the branchial stigmata are usually enveloped in a bubble of air, yet so small a supply is speedily exhausted, and, indeed, soon disappears.

The external and internal organization of such species of *Araneidea* as can exist for a long period of time under water deserves to be attentively examined; but those species which I have observed hitherto are minute, and it would require the hand and eye of an accomplished anatomist, assisted by the most delicate instruments and powerful magnifiers, to effect this desirable object satisfactorily.

Instances of long-sustained abstinence from food by animals of the order *Araneidea*, unaccompanied by any manifest diminution of vital energy, have been recorded by various naturalists, and many more might easily be added to the catalogue; I shall limit myself, however, on the present occasion, to the narration of a very remarkable case, in illustration of this fact, which came under my own immediate observation.

A female *Theridion quadripunctatum*, captured in the month of August 1829, was placed in a phial of transparent glass, and fed with flies till the 15th of October in the same year, during which interval she accomplished her final moult, and arrived at maturity. She was then removed to a smaller phial, which was

closely corked and locked up in a bookcase, her supply of food being at the same time discontinued. In this phial she remained till the 30th of April, 1831, on which day she died, without receiving the slightest nourishment of any description; yet, till the autumn of 1830, no apparent change had taken place either as regards her external appearance or physical energy. Throughout the entire period of her captivity she never failed to produce a new snare when the old one was removed, which was frequently the case; and it is particularly deserving of attention that the alvine evacuations were continued, in minute quantities and at very distant intervals, to the termination of her existence.

In publishing cases similar to that just detailed, it is desirable that dates should always be given; for Spiders, during the winter months, remain in a state of inactivity, their vital functions becoming feeble under the benumbing influence of cold; consequently, until they are invigorated by an increase of temperature, a supply of nutriment is not required.

So little appears to have been done for the purpose of determining the longevity of spiders with some approach to accuracy, that a few observations on the subject probably will not be regarded as superfluous.

A young female *Tegenaria civilis*, disengaged from the egg on the 6th of July, 1842, after quitting the cocoon was placed in a separate phial and was

abundantly supplied with nutriment. It continued in excellent health and condition apparently till the 8th of July, 1845, when it died suddenly, having completed the third year of its existence.

On the 27th of June, 1842, a young male *Tegenaria civilis* was disengaged from the egg. It quitted the cocoon on the 21st of the following month, and underwent its last moult on the 17th of October, 1843. During the winter of 1844 it became greatly reduced in bulk, and died on the 30th of March, 1845.

The egg of a *Tegenaria civilis* hatched on the 27th of June, 1842, produced a female spider, which completed its final change of integument on the 5th of August, 1843. It took its food well, and appeared to be in good health till the 6th of July, 1846, when it died, having attained to the age of four years and nine days.

Allowing for the disadvantages to which spiders are subjected in a state of captivity, I think the duration of life in the species upon which the observations were made should not be estimated at less than four years; and I have ascertained that the life of *Segestria senoculata* is protracted to an equally long period. Whether any spiders enjoy a more prolonged existence or not remains to be discovered; but there can be no doubt that *Dolomedes mirabilis, Clubiona erratica, Agelena labyrinthica, Epeïra quadrata, Tetragnatha extensa, Linyphia montana, The-*

ridion lineatum, and numerous other species do not usually survive the second winter after quitting the egg in this northern climate.

A passage in the 'Introduction to Entomology,' by Messrs. Kirby and Spence, fifth edition, vol. iv. letter xliv. p. 214, merits a brief notice; it is this:—"Spiders are reputed to be subject to the *stone*: I do not say *calculus in vesica*; but we are informed by Lesser that Dr. John Franck having shut up fourteen spiders in a glass with some valerian root, one of them voided an ash-coloured calculus with small black dots." This singular opinion seems to have originated in a misapprehension of an ordinary occurrence, which I shall proceed to explain. If the fæces of spiders, which consist of a white fluid comprising black particles of greater density, happen when voided to be suspended in the webs or among the lines spun by these animals, they assume, under the influence of molecular attraction, the spherical figure common to fluids in general when similarly circumstanced, and soon becoming indurated by desiccation, a change of colour from white to grey or greyish brown spotted with black uniformly takes place; and in this state they constitute, I doubt not, the substance which Dr. Franck mistook for a calculus.

Variations in the colour and size of spiders of the same kind, resulting from differences in age, sex, food, climate, and other conditions of a less obvious

character, as they conduce largely to the introduction of fictitious species, have long engaged the attention of arachnologists, while those arising from extraordinary organic modifications (in consequence, perhaps, of their less frequent occurrence) have been almost entirely overlooked. The importance which cases of the latter description possess in relation to physiology and systematic arrangement will be best illustrated by a few examples.

1. An immature female *Thomisus cristatus* had the two lateral pairs of eyes only; the four small intermediate ones were altogether wanting, not the slightest rudiment of them being perceptible even with the aid of a powerful magnifier.

2. An adult female *Theridion varians* was discovered to have only six eyes; the two posterior intermediate ones were entirely wanting, and the posterior eye of each lateral pair was not half of the usual size.

3. The left intermediate eye of the posterior row was perceived to be wanting in an adult female *Epeïra inclinata*, and the right intermediate eye of the same row was not half of the usual size.

4. Deficiency of the right intermediate eye of the anterior row has been remarked in an adult male *Lycosa cambrica*.

5. An adult female *Ciniflo atrox* was found to be without the left intermediate eye of the posterior row.

6. A supernumerary eye, situated between the two small ones constituting the anterior intermediate pair, has been observed in an adult female *Theridion filipes.* The total number of eyes possessed by this individual was nine, and their arrangement was symmetrical.

7. The right intermediate eye of the posterior row in an adult female *Epeïra inclinata* had not one eighth of the natural size, being merely rudimentary.

8. A short but perfectly formed supernumerary tarsus, connected with the base of the tarsal joint of the right posterior leg on its outer side, has been noticed in an adult female *Lycosa campestris.*

9. An adult *Pholcus Lyoni* presented the remarkable fact of the union of the two sexes in the same individual, the left side being that of a male and the right side that of a female (see the 'Annals and Magazine of Natural History,' 3rd series, vol. xix. p. 392).

The particulars stated in the foregoing cases, which serve to establish the fact that spiders, in common with many other animals, occasionally exhibit instances of anomalous structure, derive no small degree of interest from their novelty; but when it is borne in mind that all the examples except two have reference to those important organs the eyes (important not only as regards the function they perform,

but also on account of the extensive use made of them in the classification of the *Araneidea*), that interest becomes greatly augmented.

As spiders with four eyes have not yet been found, though such there very probably may be, it is a matter of some consequence to caution observers against mistaking a mere defect in structure, like that recorded in case 1, for such a discovery. In the case of the spider numbered 2, the symmetrical disposition of the organs of vision might induce an inexperienced arachnologist not only to assign to it a place in the tribe *Senoculina*, but also to propose a new genus for its reception, although its appropriate situation in a systematic arrangement of the *Araneidea* is plainly indicated by its other characteristics of structure and economy. Whether there are species provided with an odd number of eyes or not, is at present conjectural; should such exist, symmetry in the arrangement of their visual organs certainly may be expected to obtain; consequently, cases 3, 4, and 5, which present instances of an odd number of eyes disposed irregularly, would be regarded at all times with suspicion: as no such objection, however, can be urged against case 6, a solution of the difficulty it presents must be sought for in an accurate acquaintance with the species.

Interesting chiefly in a physiological point of view, cases 7, 8, and 9 show that a liability to irregularity

in structure is not limited to the eyes, and that those organs are subject to abnormal variations in size as well as number.

The obscurity in which the cause of these remarkable organic modifications is involved, careful investigation, conducted upon sound philosophical principles, can alone dispel.

Pl 1

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EXPLANATION OF THE PLATES.

PLATE I.

Fig.

1. The metatarsus and tarsus of *Ciniflo atrox*, exhibiting the *calamistrum*: *a*, the upper row of spines; *b*, the lower row of spines; *c*, the spur at the extremity of the apparatus.

2. The metatarsus, very highly magnified: *a*, the upper row of spines; *b*, the lower row of spines; *c*, the spur.

3. The extremity of the tarsus of the right anterior leg of *Epeïra diadema*, exhibiting the claws.

4. A lateral view of the extremity of a posterior tarsus of *Salticus scenicus*: *d*, the appendages constituting the scopula or climbing-apparatus.

5. An appendage from one of the tarsal brushes of *Mygale avicularia*.

6. A compound hair from a leg of *Tegenaria civilis*.

PLATE II.

Fig.

1. The spinners of *Ciniflo atrox* : *a*, the fourth or inferior pair, from which the material proceeds that is formed by the *calamistra* into the pale-blue bands in the snare of this species.

2. A lateral view of a superior spinner or mammula of *Agelena labyrinthica* : *b*, the spinning-tubes.

3. The left maxilla and palpus of *Mygale ursina* : *c*, the spines at the base of the former.

4. The lip of *Mygale ursina* : *d*, the spines at its extremity.

5. The right maxilla and palpus of *Mygale zebra* : *e*, the spines on the superior surface of the former.

(All the figures are highly magnified.)

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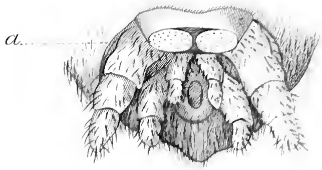

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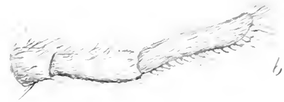

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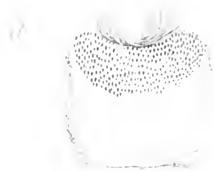

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THE END.

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